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# DIESEL and GAS ENGINE PROGRESS

IN INDUSTRY • IN TRANSPORTATION • ON THE SEA • IN THE AIR


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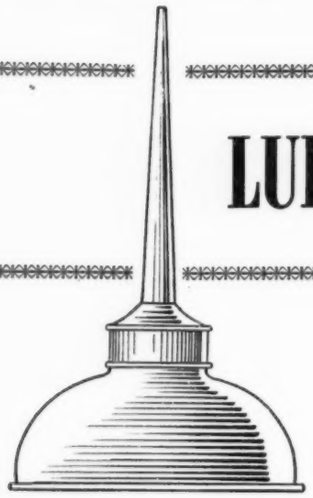


# LUBRICATION OF THE LOW SPEED DIESEL

By K. L. HOLLISTER*

THE old lumbering large low speed diesel has become, as a result of over 50 years' development, a highly efficient, skillfully enginered, precision-built machine, having a flexibility that permits the utilization of a wide range of gaseous or liquid fuels. Just as Paris was the style center, before the war good practice as regards diesel design also originated in Europe where the majority of these large diesel engines were produced. Then the situation changed. The American Diesel engineering fraternity was more than equal to the occasion and created distinctive, well-engineered designs which are a credit to American Industry.

As is often the case when mechanisms become more efficient, they require special lubrication attention. The diesel lubrication engineer, therefore, during the past several years has been faced with many new problems, largely resulting from the development of more and more power and heat in a given size cylinder; see Table I. At first, he met these problems by borrowing from European practice, leaning rather heavily on his overseas associates. This soon proved inadequate, however, and it became necessary to make a thorough study of diesel lubrication and develop new lubricants and lubrication procedures to keep pace with the rapid strides of the diesel in this country.

Lubricating a large diesel is primarily a case of preventing ring wear and promoting piston cleanliness. Not only are these two requirements interdependent, but both are influenced considerably by fuel combustion products. The problem can become complex and successful operation requires a working knowledge of the factors involved, so that in case of any difficulty the specific cause can be isolated.

Most engine deposits originate from products of incomplete combustion of the fuel or from deterioration of the lubricating oil. In attacking the problem of deposit formation, it is advisable to first make sure that all operating conditions necessary for complete combustion are complied with. Assuming for the moment that this has been done, it is then necessary to consider the factors influencing oil deterioration. These include the oxidation resistance, evaporation and dispersion characteristics of the oil, the temperatures in the engine, and design factors influencing the length of time the oil is subjected to high temperature.

*Oxidation*—Oxidation, the combining of an oil molecule with oxygen, becomes appreciable at temperatures over 200°F.; it is accelerated at higher temperatures. Time is a very important item, however, as shown in Table II. It will be noted that an oil exposed to 400°F. for 1½ hours was oxidized as much as at 300° for 45 hours. When hot oil is exposed to air, the oil at the surface is most rapidly oxidized. The products of oxidation at first remain dissolved in the oil and the oil darkens. As their concentration increases, some precipitate as fine particles which eventually coagulate and drop out, forming deposits.

TABLE I

Increase in Rated Power Output of a Popular Large Two-Cycle Diesel 1928-1948

| | Horsepower per Cylinder |
|---|---|
| Before 1928 | 120 |
| 1928-1930 | 140 |
| 1930-1932 | 150 |
| 1932-1934 | 160 |
| 1934-1944 | 175 |
| After 1944 | 200 |

*Oil Film Thickness*—The thickness of the oil film is one of the important factors determining the concentration of oxidation products. It is quite obvious that a thin film of oil will have a greater percentage of its molecules exposed to the air and a lesser quantity of oil available to hold the oxidation products.

*Catalysts*—The presence of certain materials known as catalysts accelerates oxidation. Copper is an active catalyst and, so is iron but to a lesser extent; see Table III. Certain of the detergent oils contain catalyst poisoners which greatly reduce the catalytic effect of copper on oxidation. Such oils should receive consideration if the cylinder oil comes in contact with copper or bronze piping or bearing metal.

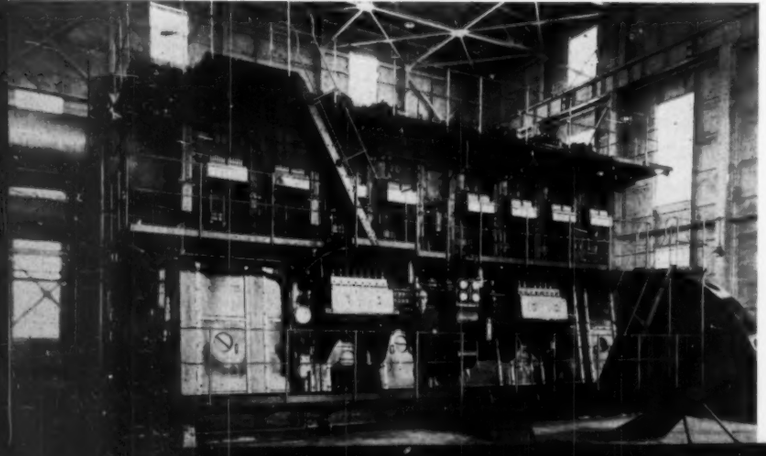
*Water*—Water also promotes oxidation, as shown in Table IV. Normally, little oxidation takes place under 212°F., but if water is present, considerable oxidation may occur at even lower temperatures. Care should be taken to keep water drained from oil tanks and jacket temperatures should be maintained above 130°F. to prevent condensation of water, one of the products of combustion, on the cylinder walls.

*Inhibitors*—To reduce piston deposits, the oil may be fortified with an oxidation inhibitor. This will increase the oxidation resistance of the oil. However, it must be remembered that any oil, regardless of its type or how well fortified, will eventually form a deposit if left long enough as a

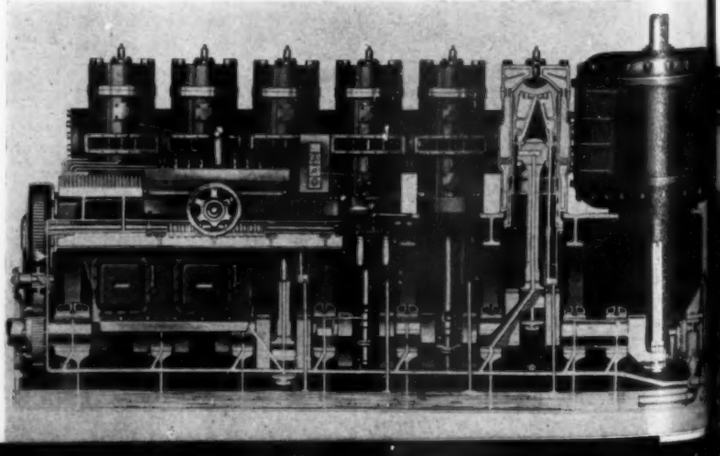
* *Technical and Research Division, The Texas Company, New York, N. Y.*



8,000 hp. 8 cylinder, 24x36, 180 rpm 2 cycle, double acting General Machinery Corp. diesel.



1200 hp. Fairbanks-Morse diesel, 2 cycle, 300 rpm, cylinders 16x20.



static thin film at the temperatures existing on piston surfaces.

*Detergents*—To improve engine cleanliness, detergent additives are incorporated in lubricating oils. The effect of detedgents in preventing the depositing of an oil's own oxidation products is not as great as it is in removing or preventing deposits from another oil or fuel. This means that detergent oils are used as cylinder lubricants most

TABLE II

Relationship of Temperature and Time for Same Degree of Oxidation (Based on MacCoull test)

| Temperature °F | Hours |
|---|---|
| 360 | 45 |
| 350 | 8 |
| 400 | 1½ |

effectively where potential piston deposits originate from the fuel or from a different crankcase oil. Detergent oils are least effective in large crosshead type diesels operating on a good fuel. Most

TABLE III

Catalytic Effect of Copper on Corrosion due to Oxidation of a Straight Mineral Oil (Based on MacCoull test)

| Hours | Weight loss, mg. at 350° Copper-Lead Bearing With Steel Baffle | With Copper Baffle |
|---|---|---|
| 0 | 0 | 0 |
| 2 | 2 | 5 |
| 4 | 4 | 75 |
| 6 | 15 | 155 |

of the heavy duty detergent oils are made from relatively non-volatile base stocks and numerous cases are on record where cleaner engines have been obtained using a more volatile straight mineral oil. In fact, it is quite well established that in many large 4-cycle engines detergents have little effect and that piston cleanliness is improved by using an oil which evaporates or burns away cleanly with very little residue.

*Volatility*—Volatility, which is just another way of saying boiling range, is usually expressed by a distillation curve of the oil. Table V shows the average boiling point and the actual rates of evaporation for two oils. It will be observed that the more volatile oil forms the least deposits but gives greater wear and higher wall temperatures under severe operating conditions. The lubricant for a given set of cylinders, therefore, should be sufficiently non-volatile to remain on the cylinder surface long enough to provide a lubricating film until it is replaced and yet be sufficiently volatile to evaporate before it oxidizes to form lacquer or carbonaceous matter. To select an oil for a given design requires a knowledge of the volatility and other oil characteristics, temperatures and other engine data, and above all a background of successful experience.

*Temperature*—The amount of deposit an oil forms on a hot surface depends on whether oxidation which is tending to create deposits prevails over evaporation and mechanical factors tending to remove the oil. The effect of temperature on the amount and nature of deposits varies with different oils. Up to a certain temperature the deposit is light and easily removed with solvents. Above this critical temperature, the deposit is largely carbonaceous and must be scraped or burned off. The critical temperature for most oils lies between 400 and 600°F. Applying this knowledge of the reaction of oil at higher temperatures, there are several steps that can be taken to reduce the formation of piston deposits. For example, a more volatile oil may be used. This means either changing to a lighter grade of the same oil or to a different type of oil. The limiting factor here is the greater tendency of the more volatile oil to permit wear.

Generally speaking, from an oil deposit standpoint, lowering piston temperatures decreases both

TABLE IV

Effect Water on Oil Oxidation (Modified Indiana test)

| | Neutralization Number after heating for 120 hrs. at 205°F with copper-iron coil |
|---|---|
| Without Water | 0.5 |
| With 20% Water | 1.9 |

piston skirt lacquer and ring sticking, although there are cases where higher temperatures have moved the critical temperature zone, at which

TABLE V

Characteristics of Relatively Volatile and Non-Volatile Oils

| | Volatile Relatively Oil | Non-volatile Relatively Oil |
|---|---|---|
| Wear—Avg. Ring Weight Loss, g., after 24 hours at 250°F. jacket temperature | 3.1 | 1.2 |
| Deposits — Thin film residue, %, after 24 hours at 450°F. | 4 | 13 |
| Liner Temperature °F, top of ring travel at 250° jacket temperature | 46[illegible] | 420 |
| Oil Characteristics, Average Boiling Point °F. | 760 | 890 |
| Viscosity, centistokes at 450°F. | [illegible]1 | 1.4 |
| Evaporation at 450° mg/sq cm/hr | 25 | 11 |

maximum carbon is formed, away from the important top ring.

Unfortunately, from a lubrication standpoint, piston temperatures appear to be increasing. Much progress has been made in obtaining more power from a given size engine. This has been accomplished in two-cycle engines by increasing the piston speed as shown in Table VI. In four-cycle engines, supercharging has boosted power output considerably. The combustion of a considerably larger amount of fuel in a given time has correspondingly increased the amount of heat released in the engine. Part of this heat has been removed by better cooling, but there has also been a significant increase in the temperature of engine parts near the combustion chamber. Pistons, which formerly were sufficiently cool so that excessive oxidation of the oil did not occur on their surface, are now hot enough to cause some oils to deteriorate and from deposits.

Although much has been done, still more can be done by the engine designer to reduce piston temperatures. There are engines, for example, which have been supercharged with no increase in piston cooling or piston sealing. Table VII shows the affect of supercharging on heat balance. Even though it is eventually converted to power or swept out the exhaust, the additional heat released in the combustion chamber raises piston temperatures as noted in Table VIII, which shows the affect of supercharging on piston temperatures and blowby. Both accelerate deposit formation.

*Oil Flow*—Piston skirts should be kept as cool as possible to reduce the possibility of oxidation and lacquer formation. The temperature of the piston skirt is usually in the neighborhood of 250°F. While the oil film on the piston skirt thickens due to oxidation, it still remains liquid and is easily removed unless it becomes overheated by shutting the engine down too quickly, in which case it becomes hard, black and brittle. If the film is allowed to remain too long during operation, it becomes a black scum which promotes ring sticking. It is important, therefore, that the

TABLE VI

Large Diesel Comparison 1915-1947

| | Cyl. Size | RPM | HP/Cyl | HP/ Cu.In. Displ. | Piston Speed |
|---|---|---|---|---|---|
| (Based on "Diesel Engines—AHGoldingham 1915) | | | | | |
| Sulzer | 18.5x26.8 | 150 | 225 | .031 | 670 |
| MAN | 23.6x36.2 | 120 | 337 | .021 | 725 |
| Carels | 20.1x30.2 | 130 | 266 | .028 | 655 |
| (Based on "Diesel Engine Catalogue" 1947) | | | | | |
| Busch Sulzer | 20.5x27.5 | 240 | 340 | .038 | 1100 |
| Hamilton | 21.5x27.5 | 240 | 375 | .038 | 1100 |
| Nordberg | 21.5x29 | 225 | 400 | .038 | 1090 |

Fulton diesel, 1800 hp. 8 cyl., 4 cycle 277 rpm.

Cutaway view of Cooper-Bessemer diesel—1,180 hp. in 6 cylinders—327 rpm. 4 cycle.

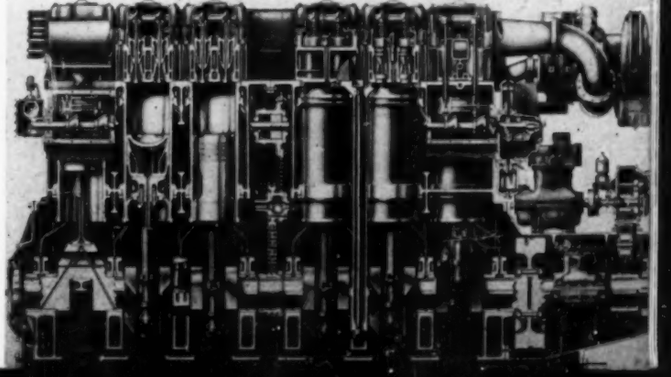


TABLE VII

Effect of Supercharging on Heat Balance—Large 4-Cycle Diesel

Percentage Basis

Total Unsupercharged Heat Output = 100

| | Unsupercharged | Supercharged |
|---|---|---|
| Shaft Output | 36 | 50 |
| Exhaust | 34 | 57 |
| Cooling Water | 25 | 21 |
| Oil Cooler | 3 | 4 |
| Radiation | 2 | 2 |
| Total | 100 | 134 |

heavy, partially oxidized oil which coats the piston skirt be continually removed. This may be accomplished by installing rings in the lower part of the cylinder which scrape the oil off the piston skirt into a sludge pocket. Injecting fresh, clean oil from a separate mechanical lubricator into the cylinders near the top of the ring travel also aids in keeping the oxidized oil from the piston skirt from reaching the ring belt area.

One way to prevent deposit formation is to increase the rate of circulation of the oil over the hot area. This can be done by feeding more oil, but any gain in circulation rate attained by this method is more than offset by increased carbon in the combustion zone. The combustion chamber is so hot that a fair percentage of all excess oil is converted to carbon. In other words, increasing the oil feed may reduce deposits in one area, but increase them in another. Therefore, to keep overall deposits down, the oil feed and consumption should be held to a minimum consistent with wear considerations. Sludge chambers at the base of the cylinder and holes in the piston behind wiper rings do, however, improve circulation without forcing excess oil into the combustion zone.

*Wear*—As engine temperatures increased, a tendency for cylinders to run dry and wear out at the top of the ring travel was noted. In studying this problem, it soon became evident that the critical factor (K) is the amount of power developed per square foot of new oil film generated. In other words, $K = \frac{HP/Cylinder.}{\pi DLN}$ Where D and L equal the bore and stroke in feet and N equals engine rpm. For example, it was found that an oil which had been used satisfactorily for years in a certain line of engines, started giving trouble when K exceeded .045. This critical K value, which of course varies with different oils and engines, is very useful in determining in advance the type of lubricant required for a specific installation. This, of course, is an admission that no one single oil can be considered ideal for all engine types and operating conditions. This is emphasized when considering the question of volatility as already explained.

The effect of viscosity on wear is shown in Table IX. From these data it may be concluded that an oil for cylinder lubrication of large diesels should exceed 50 SSU Viscosity @ 210°F. Most manufacturers specify 60 to 70.

While the lubrication engineer can frequently

TABLE VIII

Effect of Supercharging
Typical Small Engine

| | | | |
|---|---|---|---|
| Supercharge Pressure, in. Hg | 0 | 10 | 20 |
| BMEP | 85 | 122 | 155 |
| Top Ring Groove Temperature, °F. | 395 | 456 | 466 |
| Blow-by, CFH | 13 | 26 | 40 |

reduce wear by supplying a less volatile oil, this is at the expense of a greater tendency to form deposits. Accordinglp, the designer has cooperated by improving the distribution of oil to the upper

TABLE IX

Effect Viscosity on Piston Ring Wear. Small 2-cycle Diesel at 300° Jacket and 430° Cylinder Wall Temperature (at top of Ring Travel) using Paraffin Base Oil, and Low Sulphur Fuel.

| Oil Viscosity SSU at 210 F | Wear Ring weight loss, g. |
|---|---|
| 45 | 9.0 |
| 50 | 3.4 |
| 60 | 1.4 |
| 70 | 0.9 |
| 80 | 0.7 |
| 90 | 0.5 |
| 100 | 0.5 |

part of the cylinder which has been accomplished by fitting the oil leads here and by using piston rings which carry more oil to this zone. Engines which adequately distribute oil to the top of the ring travel can be lubricated with a more volatile oil and benefit greatly from a cleanliness standpoint.

In addition to controlling wear by using base oils of proper viscosity and volatility, additives can be incorporated which increase the ability of the oil to protect against wear. Certain additives increase the power of the oil to adhere to metallic surfaces, preventing rupture of the oil film. Others serve as anti-welding agents, preventing the fusion and scuffing which would otherwise occur should clean, metallic, surfaces come in sliding contact under sufficient pressure.

Other additives indirectly prevent wear by protecting against corrosion at low temperatures. Still other additives prevent the natural tendency of oils to creep away from hot surfaces.

It has also been shown that certain oils form deposits, usually on the piston crown above the top ring, which are abrasive to soft steel. Such deposits may cause vertical scratching of cast iron piston rings. Excessive clearance between the top of the piston and the cylinder wall will contribute to this type of wear.

TABLE X

Effect of Sulphur Content of Fuel on Corrosive Engine Wear

| Jackets Temperature | Average Ring Weight Loss gms. per 12 Hour Period Low Sulphur Fuel | High Sulphur Fuel |
|---|---|---|
| 80° | .32 | .80 |
| 300° | 3.09 | 3.08 |

*Fuel*—While higher engine temperature has given rise to deposit and wear problems associated with lubrication, it has reduced deposits and wear resulting from fuel combustion products. At higher temperatures combustion is more complete and condensation products are largely eliminated. In any study of lubrication of internal combustion

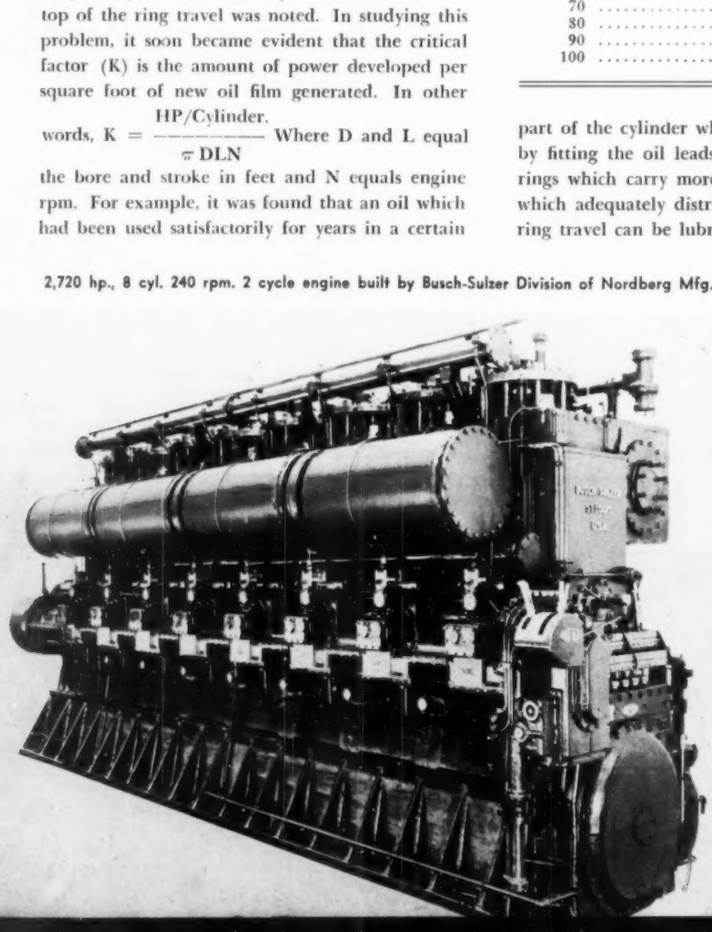
TABLE XI

Effect of Sulphur Dioxide on Oxidation
(Indiana Oxidation Test)

| Gas | Hours to form 0.1% Sludge |
|---|---|
| 100% Air | 480 + |
| 75% Air, 25% $SO_2$ | 85 |



2,720 hp., 8 cyl. 240 rpm. 2 cycle engine built by Busch-Sulzer Division of Nordberg Mfg. Co.



Worthington 1760 hp. 8 cyl. 360 rpm. 4 cycle diesel.

engines, consideration must be given to the important effect fuel has on engine deposits and wear. The fuel characteristics involved in this connection are viscosity, carbon residue, water and sediment, distillation, cetane number, and sulphur content.

Since poor atomization causes poor combustion, it is desirable to control the size of the fuel droplets injected into the combustion chamber. The viscosity of the fuel will determine the size of the fuel droplets for a given orifice and pressure. Viscosity, in turn, can be controlled by varying the fuel temperature. This requires heating the fuel, if necessary, to keep the viscosity under 150 SSU.

There is a limit beyond which fuel should not be heated. Most fuels can be safely heated to 180°. Above this temperature heater fouling is apt to be serious and volatilization may occur. Preheating the fuel also accelerates gum formation in the injector. This can, however, be controlled by proper cooling of the injector either by water jacketing or by circulating a large amount of excess fuel back to the fuel tank.

Carbon residue is a test in which the fuel is burned under controlled conditions and the residue determined. Most large diesels can satisfactorily burn fuels with carbon residues up to 4% and under favorable temperature over 10%. Carbon craters on the injection nozzle tips usually indicate that a high carbon residue fuel is in use and these craters should be removed before they interfere with the fuel spray. Since carbon residue is a decomposition product of liquid petroleum, it cannot be reduced appreciably by filtration of the fuel.

Water and sediment, however, are foreign materials that can be removed by proper fuel purification. Centrifugal purifiers are more generally used and will effectively remove water and sediment.

TABLE XII

Typical Fuel Oils Used in Diesel Engines

| | A | B | C | D |
|---|---|---|---|---|
| Gravity, API ..... | 13 | 16 | 23 | 27 |
| Flash, °F ..... | 210 | 200 | 190 | 110 |
| Viscosity SSU at 100°F .. | 1700 | 515 | 100 | 50 |
| Viscosity SSF at 122°F ... | 75 | 28 | 14 | 13 |
| Temperature for 150 SSU, °F ..... | 175 | 145 | 80 | 35 |
| Carbon Residue % ..... | 11 | 9 | 6 | 2 |
| Sulphur % ..... | 2.0 | 1.3 | 1.2 | 0.5 |

Tests have shown that poor combustion, as evidenced by smoke, is a function of the Cetane No. and the distillation characteristics. The Cetane No. measures the ignitability and distillation, the volatility; both combining to indicate the relative soot forming properties of the fuel.

Large diesels have burned high sulphur fuels for years with no difficulty, provided the sulphur is combined in a non-corrosive form. This latter point may be ascertained from the results of the copper strip corrosion test.

Even the non-corrosive forms of sulphur, however, cause corosion if engine jacket temperatures are so low that water condenses on the cylinder walls during operation. The sulphur burns to $SO_2$ which in turn dissolves in any water present forming corrosive sulphurous acid which can cause rapid cylinder wear. The effect of sulphur on cylinder wear is illustrated in Table X, which shows the results of repeated engine tests of low and high sulphur fuels at low and high temperatures. At low temperatures, high sulphur fuels result in wear from corrosion by sulphurous acid formed by absorption of sulphur dioxide in water condensed on cylinder walls. At high temperatures, this corrosive wear does not occur.

The high temperature data in Table B was obtained using a fairly volatile oil and very hot cylinder walls so that any corrosive products formed would have ample opportunity to attack the relatively dry ring metal. Even under these conditions although the engine was sensitive to wear, as shown by the high weight losses, no evidence of corrosion due to sulphur at high temperatures was found.

It has been reported by several investigators, however, that sulphur does give difficulty under high temperature operating conditons by accelerating deposit formation causing increased abrasive wear. Such deposits are often easily removed by soap and water which will not touch ordinary petroleum decomposition products. The accelerating effect of sulphur dioxide on oxidation, shown in Table XI, may explain in part the increased deposits formed from high sulphur fuels.

Since there is every evidence of an increasing supply of high sulphur fuel, this problem is under considerable investigation at the present time. Already, ways of overcoming the disadvantage of high sulphur have been developed by the metallurgist, the engine designer and the lubricating oil manufacturer.

There has also been a definite trend toward the use of heavy fuel oils in large diesels. The variations in fuels available are shown in Table XII. A and B are heavy fuel oils. C is a light bunker fuel and D is a topped crude. The high speed diesel operates well on the distillate fuels, lighter than those tabulated, and the larger diesels have little difficulty digesting the light bunker fuel. The heavy fuel oil is, however, a real problem, but good progress in the handling of such fuels is being made. The heavy fuels require good purification, heating equipment, well-cooled injectors, good atomization, hot combustion chambers and detergent or heavy duty lubricating oils.

To burn the very heavy fuels, it also is usually necessary to increase injection pressure and intake air pressure. Extreme care must be taken to make sure jacket temperatures are always maintained high enough to insure good combustion. It is also advisable to switch to a lighter fuel whenever it is necessary to operate at light loads, and when starting and stopping.

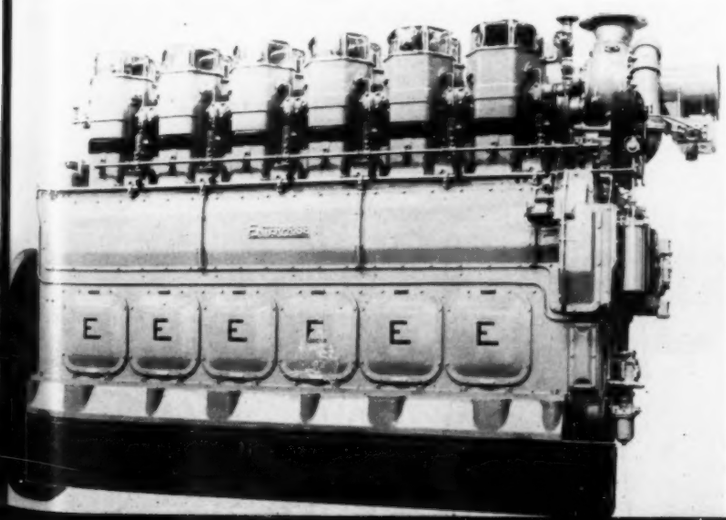
Tests have shown that changing from a light to a heavy fuel increases exhaust temperature, fuel consumption and lubricating oil purifier deposits.

*Mechanical Lubricator Fluid* – Detergent oils have proven effective in preventing deposits of soot and other combustion products from adhering to engine parts. Before the detergent oils could be used in large diesels, it was necessary to develop special fluids for the sight glasses of liquid filled mechanical lubricators. When detergent oils are used with water or glycerine, the lubricator solution may become cloudy, be carried over with the oil or affect drop formation due to additive action. Some natural waters and certain commercial glycerines fortuitously happen to contain impurities which prevent their going into solution with detergent oils. Ordinarily, however, small quantities of a special powder must be added to distilled water to make a lubricator solution which will be satisfactory for use with detergent oils.

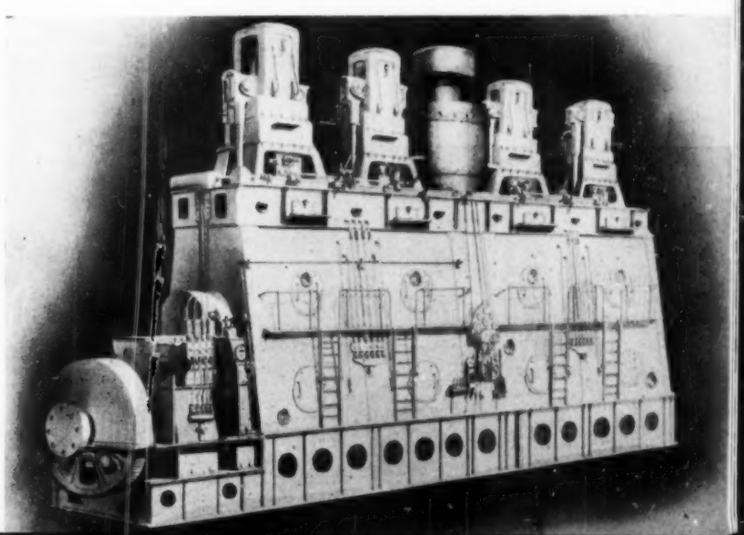
*Used Oil Analyses*—The lubricating oil should be kept in good condition, this being particularly necessary when the oil from the crankcase also lubricates the cylinders. Dirty or partially oxidized oil obviously is more apt to cause piston deposits than oil in good condition. The analysis of the used oil, while usually made to determine its condition is even more valuable as an indicator of engine operation.

The presence of an excessive proportion of oxidized oil as shown by the analysis may indicate the engine is running too hot, while a high percentage of fuel soot is a sign of poor combustion.

Enterprise 1300 hp., 6 cyl. 16x20, 375 rpm. diesel.



6000 hp. Sun Doxford diesel—4 cylinder, 4 cycle 94 rpm.



Iron or bearing metal in the used oil is evidence of rust or wear. If the ash also contains foreign abrasive matter, this is usually assumed to be the cause of wear and the source should be eliminated.

Water may be evidence of a defective cooling system or of condensation from cold operation. Fuel dilution may come from a fuel system leak or it may indicate incomplete combustion, faulty injection, etc.

*Deposit Analysis*—Typical analyses of the crankcase oil and deposits from the piston skirt and top ring groove of a normally functioning engine are shown in Table XIII. This was a large engine operating on a light distillate fuel and injection nozzles, timing, etc., were properly adjusted. Accordingly, a minimum amount of soot was being formed. Even so, the reduced additive content and the high carbonaceous percentage show that a considerable portion of the ring groove deposit is soot. The lack of oxidation products in the crankcase oil, which also lubricated the piston, shows that the piston skirt deposit is largely due to oxidation of the oil at that point. Since an abnormal condition may produce an abnormal type of deposit, differing from Table XIII, an analysis may furnish a clue as to its source.

TABLE XIII

Typical Analyses from Normal Engine

| | Crankcase Oil 250 hours No filter | Deposit from Top Ring Groove | Deposit from Piston Skirt |
|---|---|---|---|
| Oil | 99.6% | 13% | 31% |
| Carbonaceous | 0.1 | 81 | 20 |
| Oxidation products | 0.0 | 4 | 44 |
| Additive Metal | 0.3 | 2 | 5 |
| Total | 100% | 100% | 100% |

*Oil Purification*—The contaminants which the various types of purifier remove are shown in Table XIV. The degree to which they are removed depends on the size of the purifier. In the selecting of a purifier, therefore, both type and size must be given consideration. In the case of filters, a small filter size can be compensated for by more frequent replacements. Most purifier manufacturers have worked out a set of recommendations based on horse-power, which cover normal operations. Larger purifiers are needed, however, if temperatures or other conditions cause excessive oxidation, or if a lot of power is produced from a small engine, as is the case in highly super-charged four-cycle diesels where the pressures are high- blow-by is increased and more soot present in the crankcase oil. If a heavy fuel is used, the amount of crankcase contamination with fuel combustion products will be considerable; in fact, the amount may become so great that a combination of purifiers may be necessary. For example, a centrifuge may be used to remove the bulk of the contaminant and a fine filter for final purification.

TABLE XIV

Lubricating Oil Contaminants Removed by Purifiers

| | Solids | Sludge | Water | Fuel |
|---|---|---|---|---|
| Metallic Filter | X | | | |
| Cellulose Filter | X | | * | |
| Fuller's Earth Filter | X | X | * | |
| Centrifuge | X | | X | |
| Clay Reclaimer | X | X | X | X |

* Small quantities.

Clay may be used as a filtering medium even with additive oils, at least in some cases. Table XV gives typical results of a large diesel operating with a clay filter and a detergent oil compared with a cellulose filter on the same operation. The clay filter initially removed the additive, but soon became saturated with respect to the additive, although it remained suitable for removing oil contaminants. As new oil was added to the system, the additive content eventually returned to normal.

TABLE XV

Effect Type Filter on Additive Content Heavy Duty Oil in Large Diesel Having Single Lubrication System

| Hours | Additive Content—% Waste Filter | Clay Filter |
|---|---|---|
| 0 | 100 | 100 |
| 250 | 95 | 23 |
| 500 | 91 | 50 |
| 1000 | 88 | 87 |
| 2000 | 88 | 87 |

There is another point that must be given consideration when using clay with detergent oils, and that is the reduced flow rate. For this reason, clay purifiers are more satisfactory with detergent oils where the oil is not too badly contaminated.

In connection with reclaiming with activated clay, since the clay is so much more effective at high temperatures, the reclaimer should be operated just below the flash point of the oil. The advantage of operating at the elevated temperature with the proper clay dosage is shown in Table XVI. It should be remembered, however, that effective reclaiming can be expected to completely remove the additives present in the sued oil.

TABLE XVI

Effect of Temperature and Clay Dosage on Removal of Corrosive Oxidation Products by Reclaiming (Based on MacCoull test)

| Oil | Bearing Test Weight loss, Mg. |
|---|---|
| New | 5 |
| Used | 51 |
| Reclaimed at 200°F, 1.0% clay/ gal. | 26 |
| Reclaimed at 435°F, 0.5% clay/gal. | 18 |
| Reclaimed at 435°F, 1.0% clay/gal. | 6 |

*Bearings.* Manufacturers have for years employed tin base babbitt as a standard bearing metal with excellent results, because of its conformability, embeddability and anti-friction properties. Its load carrying ability is definitely limited, however, and other soft metals such as lead hardened by small percentages of arsenic, calcium, silver or copper, are now in general use. As power outputs increased and bearing loads became more concentrated, combinations of various metals have been developed having greater load-carrying ability. These are too numerous to mention but include babbitt-lined bronze, copper-lead, cadmium-silver, aluminum-tin, lead lined silver and lead-filled silver grid. Each of these bearing metals requires special lubrication treatment and should not be used indiscriminately.

TABLE XVII

Effect of Amount of Lead in Bearing Metal on Resistance to Corrosion

| % Lead in Bearing Alloy | MacCoull Corrosion Test Mg. Weight Loss, 10 hrs. at 350°F Heavy Duty Oil | Straight Mineral Oil |
|---|---|---|
| 0 | 0 | 0 |
| 92 | 8 | 20 |
| 96 | 13 | 230 |
| 100 | 23 | 900 |

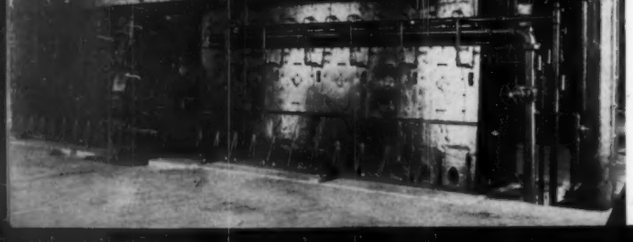
A most important bearing characteristic from a lubrication standpoint is the lead content of any metal exposed to the oil. This is because oxidized oils have a tendency to dissolve lead as illustrated in Table XVII. To avoid so-called oil corosion, it is advisable to use an alloy of 8-10% tin in lead rather than pure lead as a bearing coating.

In selecting an oil for the bearings of a large diesel it must be remembered that the same oil often serves as a piston coolant and may reach the cylinders in considerable quantity. With these considerations in mind, the crankcase oil viscosity varies from 200 to 300 SSU @ 130°F., the type depending on the purification system employed and the bearing metals involved.

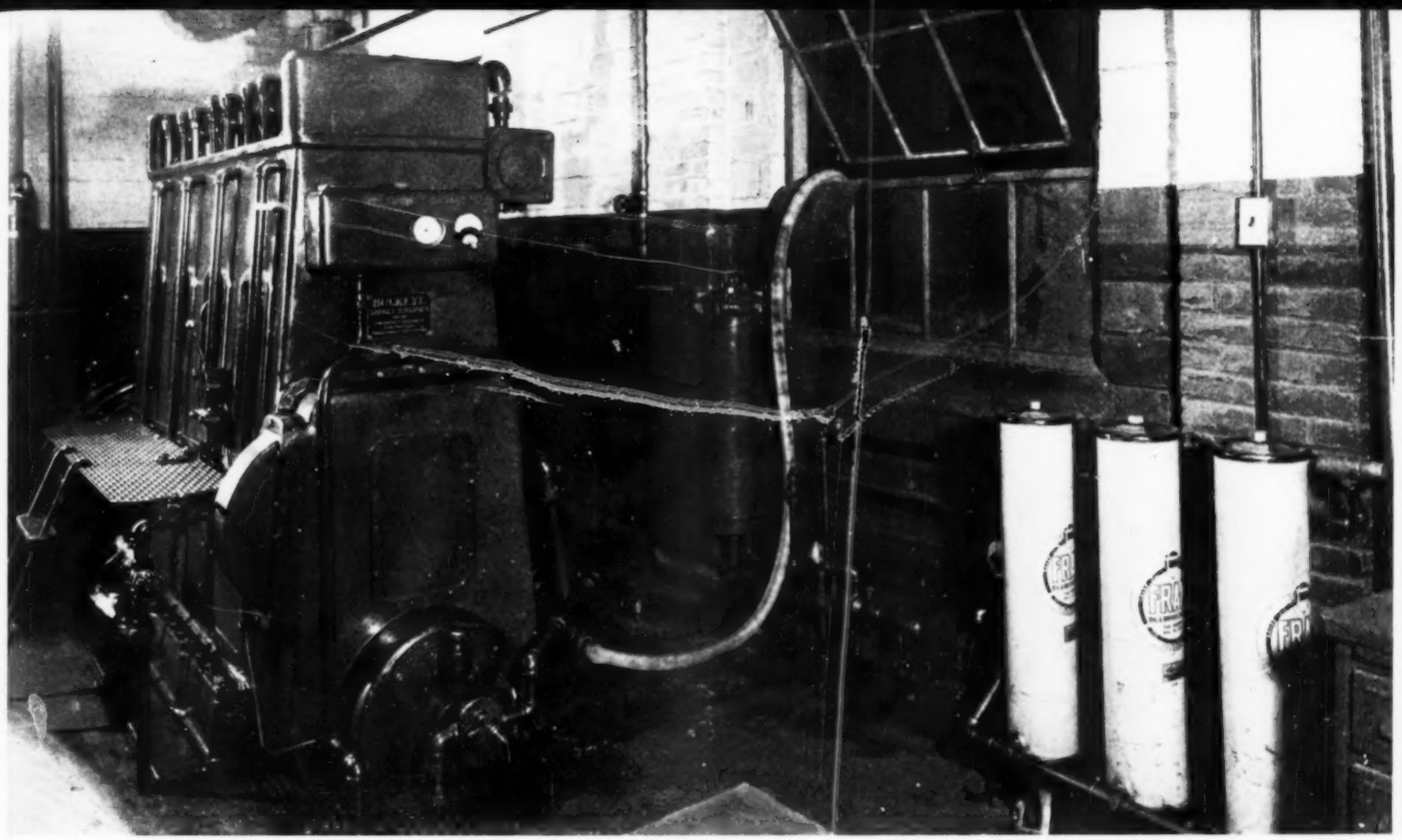
*Crankcase Ignition*—For a mixture of oil vapor and air to be inflammable, the oil vapor content must be at least 5% and not more than 15% by weight. Sampling of numerous crankcases of both high and low speed diesels with both vacuum and positive pressures on the crankcase has failed to disclose any appreciable petroleum gases in the engine. Analysis of blow-up gases shows them to be largely air which explains the fact that the crankcase atmosphere is mostly air (with a small percentage of carbon dioxide) in which are suspended fine particles of oil as a mist or fog but

. . . . . *And now please turn to page 64* . . . . .

2460 hp. Rathbun Jones diesel, 12 cylinders, 4 cycle, 257 rpm.



1650 hp. Chicago Pneumatic diesel—8 cylinder, 4 cycle, 327 rpm.



Overhaul periods on this Buckeye Diesel were increased from 8000 hrs. to 20,000 hrs. after installation of the industrial type lube filters, seen lower right.

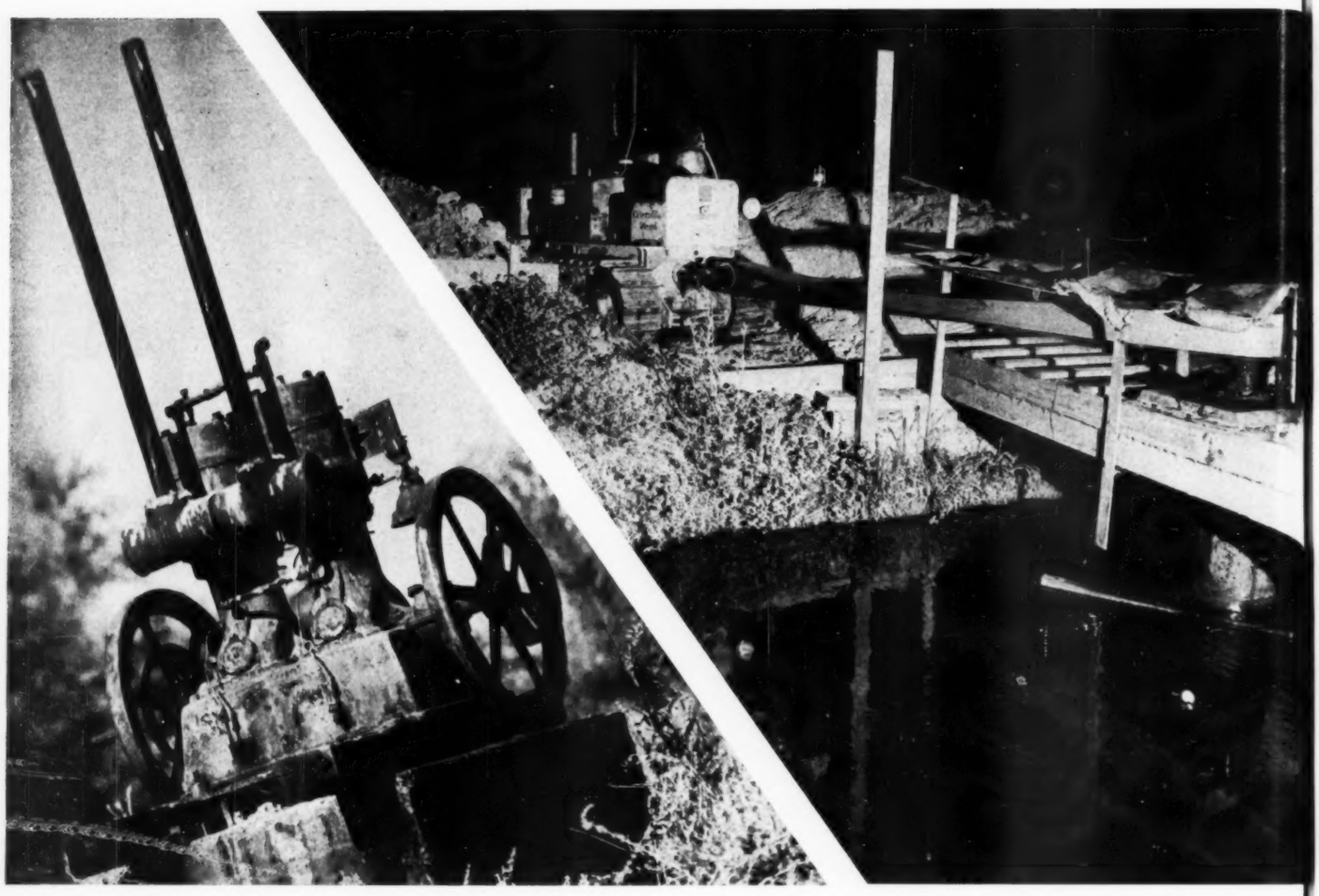
No. 3 piston, below, had all rings free after 20,000 hrs. as did No. 4 piston. No.'s 1 & 2 had one ring stuck.

# Overhaul Periods Extended By Oil Filtration

THE Springfield Bronze and Aluminum Company of Springfield, Massachusetts, supplies power to its foundry with a Diesel generator. The 150 hp. Buckeye Diesel drives a 100 kw. generator 24 hours a day supplying electricity at a cost of less than a cent per kwh. Up to two years ago the engine was overhauled every 11 months and generally the condition of the engine necessitated this routine. Each inspection of the pistons at these periods showed badly stuck rings and poor lube oil conditions. A. R. Lafontaine, Chief Engineer of the company, decided that the situation should be corrected and called in some expert advice on the matter of lube oil control. As a solution three new oil filters of Fram manufacture were installed on the engine. Now, after three years, the value of the filters can be cited chapter and verse. We'll let Mr. Lafontaine tell you himself.

"Prior to installing the three Fram filters, we overhauled our Buckeye after every 8,000 hours. We'd find the lube oil black with dirt and other contaminants, the pistons and rings in very poor condition, with nearly every ring at least partially frozen in the grooves. Now we overhaul every 20,000 hours nearly three times as long as operating period, and find the general condition of the engine very good. After 833 days, the last overhaul showed No. 1 piston—furthest in line from the oil pump—to have the oil rings entirely free, the compression rings all free, except the two top rings, and one of those was partially free. No. 2 piston had all rings free, except that the top ring was frozen for about a quarter of the way round. No. 3 piston and No. 4 had all rings free. The condition of the pistons appeared very good and the blowby was at a minimum."

Mr. Lafontaine stated that his Diesel uses the same Texas Ursa D. oil as it did when other filters were installed. Furthermore he figures that the average cost of keeping his lube oil clean to a .01 naphtha insolubles standard, is 2 cents an hour, with an oil change period of 1,000 hours. This is compared with his previous costs of changing oil every 200 hours.



22-year-old "Semi-diesel" did its share of pumping during recent drought in California. Called the Victory, the engine was built at Niles, California during first world war.

Modern counterpart of the old timer, Caterpillar D-6 does night duty on a water-pumping assignment near Robbins, California.

# Man the Pumps... WITH DIESELS

*By* F. HAL HIGGINS

THE chickens are coming home to roost on the great California power company lines that have been shoving the diesel engine off its irrigated pumping and industrial bases over the past 15 years. Briefly, the "high lines" are over a barrel between "ole debbil" Government and popular resentment against their alleged sins of omission and commission. The electric power generated from falling water and carried to farm, factory and home for light, power and heat has been caught out on the limb of post-war boom of California population, industry and agriculture. The high line folks mis-judged this mushrooming demand in trying to stave off Government bureaucrats from moving in on the state's water development. Then came two dry winters to lower water reserves in reservoirs and underground water tables.

The drought crisis has brought California a Power Czar who says who shall get how much electric power and when for his farming, business and home. When this power czar declared a 20% cut in electric power for everybody on top of daylight saving, rationing of store and theater signs at night, etc., there was precipitated a mad scramble by owners of irrigated farms, industries and business for diesel engines. Every diesel manufacturer and dealer in the California-Arizona-Nevada area immediately felt the demand in a swamping wave of telephone and personal calls for diesels.

But California is diesel-minded to start with as this power crisis descends on this state plus all the rest of the Southwest. San Francisco, Los Angeles and Seattle each has both manufacturing and sales with service outlets to install them and keep them running. While St. Louis got a slight jump on the San Francisco Bay area in starting to build the diesel commercially, it is only a step behind with stationary power diesels while it has led the world in tractor and pumping installations of this type. On top of this diesel background of the West Coast areas, there is a skilled service background that is rooted in the Gold Rush days and finally sharpened in the recent World War II production and service under pressure of high labor costs and insatiable demands.

So, in this drought-war scare crisis that has precipitated an overwhelming demand for power insurance against catastrophe it is with more than a little pride that the writer can set down the facts of an industry delivering the answers to its public when called upon in a crisis. There is a lot of spoken and written resentment against both Government Bureaus and corporation High Line misjudgment of the mushrooming population's needs. Generally speaking, however, the diesel buyers are business men in both agriculture and industry and prefer the local corporation public utilities to the politically-minded and -staffed federal bureaus. The P.G.&E., for example, has developed to its size and power by rendering economical service to the public—farm and city, homes and business. However, everybody feels that the big power line management slipped up in allowing itself to be caught out on a limb in forecasting the needs for more dams to supply the increased waterpower. So, today, the farm and metropolitan newspapers are full of "messages" from the P.G.&E. explaining its position and why these late March-April rains can't end the power problem now.

Engine builders and dealers recall their products have been swept off their pumping bases in such areas as they had started powering with cheaper irrigation water when diesels started appearing some 15 years ago in the Antelope Valley, for example. The writer remembers seeing Atlas, Venn-Severin, Caterpillar, Fairbanks-Morse, Buda, and Waukesha diesels going into this area about 75 miles northeast of Los Angeles some 12 to 15 years ago. Soon, the power line officials took note, glanced at comparative costs, and lowered their high line rates just enough to wipe out the diesel installations. Diesels were replaced by high line hook-ups that were quiet and required no refilling of fuel tanks to keep the engines going. That went on in every area where the diesel trend for irrigation pumping got started. True, it was the diesel engines that lowered the electric rate so the farmer was the big gainer in that area, but each idle or emptied diesel base was bad advertising for the efficiency of the diesel engine compared with electric high line power. But the engine builders and dealers are getting a lot of straight-from-the-heart welcome talk from farmers this time. They know a diesel engine even as a stand-by in case of power failure or State Power Czar order for a cut is a guarantee of independence for the owner from both Government and private power line failure from overloads, accidents or war.

Just to give the reader the tenor of the California live stock producer's thoughts about the power line, let's quote a paragraph or two from the California Cattleman for April, 1948:

"Penny Wise, Pound Foolish:

"The Pacific Gas and Electric Company has the honor along with another great public benefactor, for making one of the greatest economic blunders in the history of the State. The hearings held by the Public Utilities Commission at San Francisco last month on the power shortage, brought out in glaring boldness how this company missed the boat. To be sure this company could not foresee the drouth, but the impact of the drouth on the economy of the State would not have been so disastrous had it refrained from its 'dog-in-the-manger' attitude toward power development.

"The stiff-necked policy of the company, for example, was carried to the extreme of denying plain warnings by the Bureau of Reclamation as early as February, 1946, that a serious power shortage was impending. President James B. Black of the P.G.&E. at that time told a congressional hearing in Washington: 'There is no shortage now, there will be none.' Even a year later, after Richard Boke, Regional Director of the Bureau of Reclamation, warned again that the entire private and public electric systems in Northern California would be without adequate reserves in 1951, the P.G.&E. contradicted him with a bold statement declaring 'there is no reason for a serious concern about a possible power shortage.' These assuring statements from those in high places, lulled the ranchers into a sense of false security and set the stage for the greatest disaster for California agriculture.

**Water Shortage After 2-Year Drought in California Brings Million H.P. Diesel Demand from Irrigated Farms, Industry and Business**

"The lack of vision on the part of these utility officials was destined to hit the stockmen in still another direction. The 20 per cent cut in power, virtually placed the meat packing industry on a four-day week, which created a bottleneck for livestock that had to go to market. The California Cattlemen's Association and the Wool Growers jointly petitioned the Public Utilities Commission to allow the packers to continue their normal operations until the stockmen could move their distressed herds to market. We pointed out to the Commission that it was a question of cattlemen reducing their operations similar to the close of an industrial plant, but that it was a step to liquidate, and that every avenue must be left open to do the job."

The California Wool Grower's columns have been full of information on pasture lands available in every state west of the Missouri river for the shipment of breeding sheep from California to save the flocks from being completely dispersed. Idaho, Colorado, Nebraska, Oklahoma, Wyoming, Washington, Oregon, Montana, Utah listings of available pastures for drought-routed sheep filled pages issue after issue the past few months. One driving up and down the state noted two compelling facts: feed supplies were being exhausted to stop carrying live stock any longer here, and many light weight cattle and sheep were being trucked to market to cut the potential meat supply for coming months later this year and next. Where breeding stock was going to market, that meant a curtailment of meat supplies—beef as well as lamb—for future years at a time when demand is keeping meat prices high. Live stock is a type of farming the producer doesn't get into and out of quickly. It is built up on long 7-year cycles in beef, with sheep only relatively shorter because of faster reproduction.

But live stock men all up and down California are installing diesels. Near Lemoore, on the San Joaquin West Side, the writer stopped in to see a newly installed GM diesel on a Johnston pump. It had just been hooked up a few days before and was pouring out a 12-inch stream of water to keep the beef herd on that ranch instead of sending it to the slaughter pens and far pastures in Idaho or Montana at high freight rates. In fact, the rancher had taken in a neighbor's cattle to help him out. The railroads are are also catching the farmer's wrath in not granting distress freight rates to move the cattle and sheep from California to these far pastures. Other neighboring ranches were ordering and installing from 6 to 15 diesel engines each and eliminating high line hook-ups.

Glenn and Colusa counties, 100 to 160 miles north of San Francisco, set a big diesel pattern for solution of the water power problems brought on by drought. In the writer's survey of the rice producing counties of the State, a reply from Glenn County Agricultural Commissioner P. V. Harrigan pointed with pride to the new $120,000 diesel pumping plant for Glenn-Colusa Irrigation District. The officials were putting it in to solve the water shortage so effectively they would not have to cut a single acre off the water-drinking rice crop as a result. The answer so intrigued the writer, he called up the Enterprise Diesel Engine Co. office in San Francisco to learn more. The manufacturer referred to its sales agency for this territory, King-Knight Co. of San Francisco. A call at their office found the floor covered with Waukesha, Buda and Hallett diesels. Some of the Waukeshas were gasoline jobs to be hooked up to natural gas lines in areas like Bakersfield where natural gas is the cheap handy power fuel.

"Yes, we're loading that 1500 hp. Enterprise


One of six International diesels in the ranch shop of Sherman Thomas which are used for pumping irrigation water to 12,000 acres in the San Joaquin Valley.

Direct drive hook-up of General Motors diesel to Peerless pump near Lemoore, Cal. Water from this installation saved the day for crops and cattle.

diesel this afternoon to go up to Hamilton City tomorrow," replied Mr. King as he told where and when to see it installed on a base at the side of the Sacramento, where the giant Byron Jackson pumps lift the Sacramento river water into the canal system of the Glenn-Colusa district. "We have other big installations of Enterprise diesels in sight, too," said Mr. King. "I can't tell you more until the deals are closed, of course. But there's another diesel demand crowding us—standbys in case of power line failures in office buildings, little factories, baby chick hatcheries, ice plants, bakeries, and so on through the list. Go down to the Russ building and see that new Hallet diesel we just installed in the basement to insure that big skyscraper office building of light and elevator service in case the power lines should fail. In emergencies like fire, bombings, etc., keeping lights and elevator service going would help prevent panics, you know."

Your Old Reporter picked up his camera and stopped in at the Russ Building on famed old Montgomery street where the Pony Express arrived one night back in 1860 to open that historic saga of horse transportation. The Russ building engineer showed the little Hallett diesel hooked up in a snug little corner ready for emergency if and when it might happen. "It is a mighty sweet little job, too," proudly said the engineer.

Remember the story of Stanley Moore of Stockton and his Allis-Chalmers and GM truck and engine dealership? DIESEL PROGRESS ran the story a couple of years ago when Stan was winning Navy "E's" for production of boats for the U. S. Navy in the recent war. Well, Moore, as the writer hinted at the time, is one of the longest-sighted engineering-sales geniuses in the industry—anywhere. Not only did Moore size up the war as a double-barreled opportunity for him to serve his country and his public in his northern California-Nevada territory, but he sold his fine modern factory in which he built the Navy boats, disk harrows and ridgers to the International Harvester Co. for their western farm machinery factory. Then he went up the road five miles to the other edge of Stockton on the Sacramento highway, bought a piece of ground where the new freeway around Stockton was to come and proceeded to build a set of buildings to store, show, sell and service the lines he was handling as a dealer. Allis-Chalmers tractors and GM trucks and engines are still his main lines, but there are also Koehler power shovels and draglines, Lincoln welders, Ingersoll-Rand compressors and a dozen other heavy construction items that balance the line for contractors on road and street work.

The showroom offices and parts and shop are all in one long building. But opposite this main building across a paved space is a storage building and warehouse almost as big. Also, in this building is a second shop. At least 50 GM diesel engines were seen in the two buildings and on the shop floors—all sold and being shipped out direct, tested on the special testing floor of the shop, or assembled and mounted and connected on a truck for a side show company whose manager had decided "the show must go on." It was a rush job with a crew of skilled diesel men working on it to turn it out by Saturday night. A few war surplus diesels were seen on the floor of the Moore shop, some being brought in by customers for mounting for

certain jobs and a few being rebuilt by the shop to go onto installations Moore could stand back of.

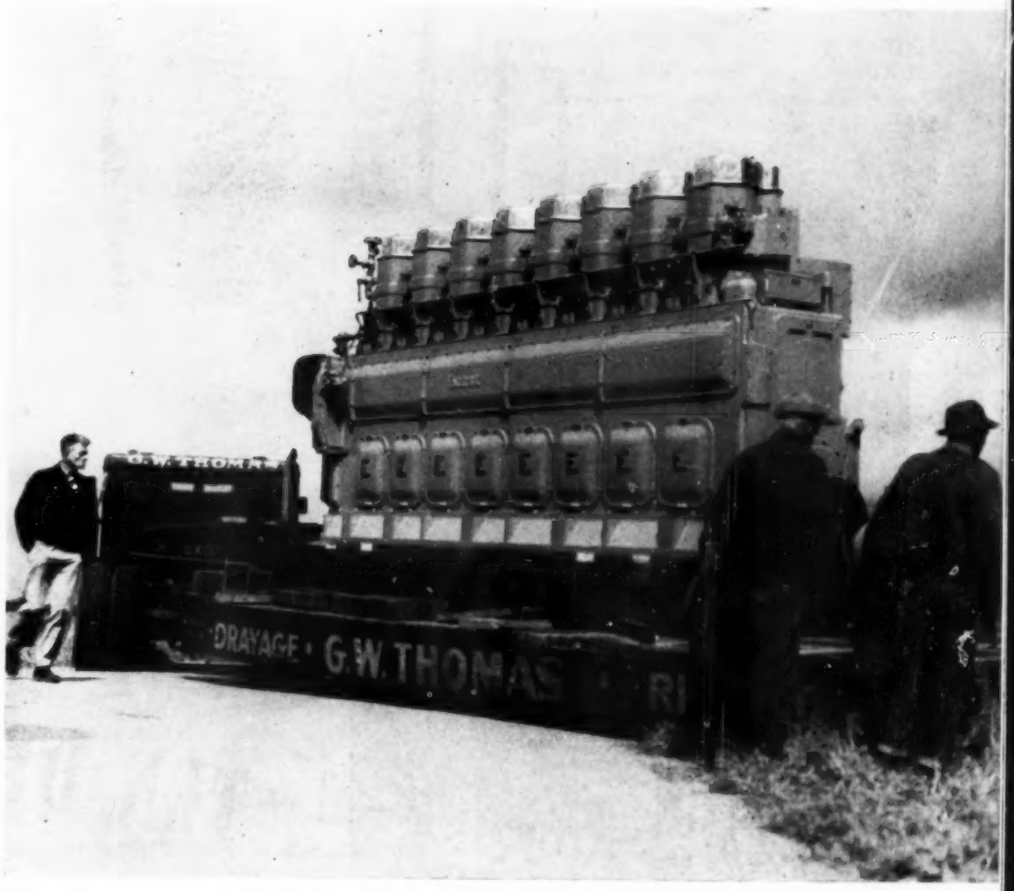
Some of the Los Banos area farmers were complaining at the Government policy of selling their war surplus diesels only in big numbers that farmers couldn't touch but which the large dealers could pick up at very low per unit prices and then turn and sell to farmers at 10 to 12 times the prices they paid. Old diesel men who know their engines and the service requirements, however, claim these war surplus diesels will hit the manufacturer because of the lack of service sold with them by a recognized dealer with service. But the West Coast farmer is a rather advanced diesel operator and knows the importance of service with his engine-powered equipment. Hence, the established dealers are getting the big preference.

International Harvester's newly opened Oakland Branch house that serves Nevada and northern California is proving a very important key to that century-plus-old firm that was built on service to the farmer. Branch Manager Knudson and his staff of specialists report they are getting the finest kind of understanding and backing from the factory in pouring a stream of diesel engines from the Mid-West IH factories to California to meet the crisis. Not only are all the older models of IH diesels coming in volume, but the new UD24, which is just breaking into the production column after being developed and tested for the big new diesel TD24 tractor in logging and dirt moving is coming through. The UD24 is the same engine that goes into their big tractor. But IH dealers at Stockton, Sacramento, Woodland, Salinas, Bakersfield, Santa Maria, San Jose and such strategic spots on the irrigation map are all getting International diesel engines and rendering expert service to hook them up to new and old pumps on the farms and ranches in the territory.

Dealer Otto Zentner at Los Banos with a branch at Gustine, had added a well service truck to his portable dealer equipment in order to better serve his farmers and get acquainted with them to help sell his IH line of tractors and farm machines and implements. "I am adding a line of pumps," said Otto, "taking on the Western Pump built at San Jose, in order to meet this drought crisis." A visit to his crew on a ranch 8 miles away found them with their well service truck at work drilling a new well and getting ready to put in a new pump with IH diesel engine to power it.

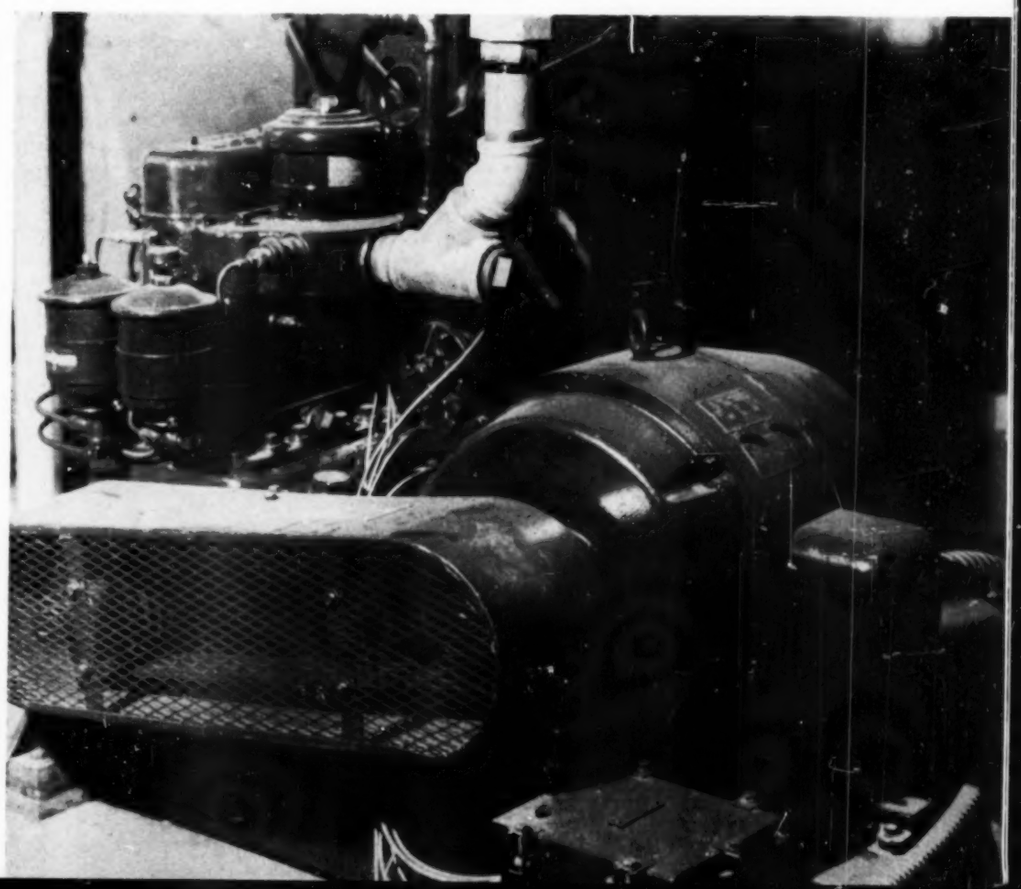
Caterpillar dealers all over the map were very much on the job in getting new diesels and servicing those already in over the past few years. At Los Banos, the Halton Tractor Co. engine salesman guided the writer out to the San Joaquin river, which appeared as a dry, sandy, willow-spotted bed wandering through the country. On the east side, however, he ran into a fleet of big Cat diesel tractors pulling levelling scrapers as John Harmon levelled 1500 acres for new crops. Scattered over the new land were six new wells with Peerless pumps powered by Caterpillar diesel engines.

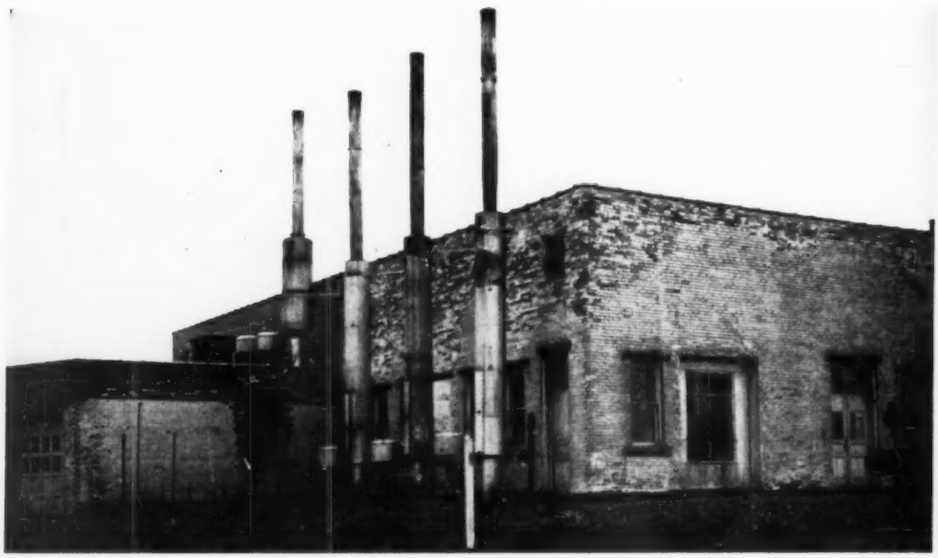
A month of rains has taken the Power Czar's 20% electric power cut and checked the hysteria. But this diesel engine demand for agriculture, business and industry is a long-pull trend that will take a million or so horsepower in the next year or two before enough dams are built to insure safety from drought and restore water tables.

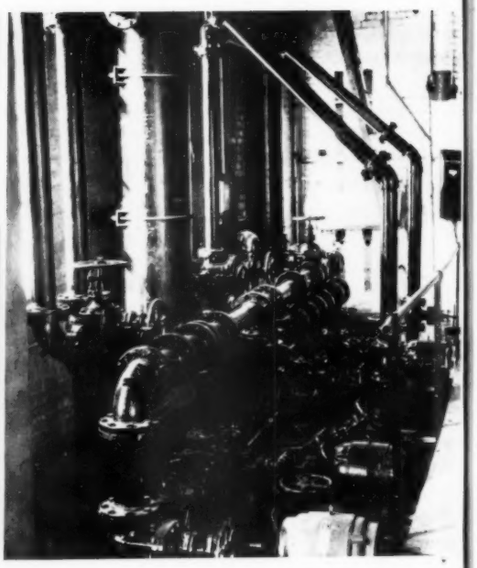



New 1500 hp Enterprise diesel arrives on site on banks of Sacramento river to take over pumping duties for Glenn-Colusa Irrigation district. Diesel-engined truck did the hauling.

For emergencies Hallett diesel was installed in San Francisco's Russ Building to supply lights and elevator service.

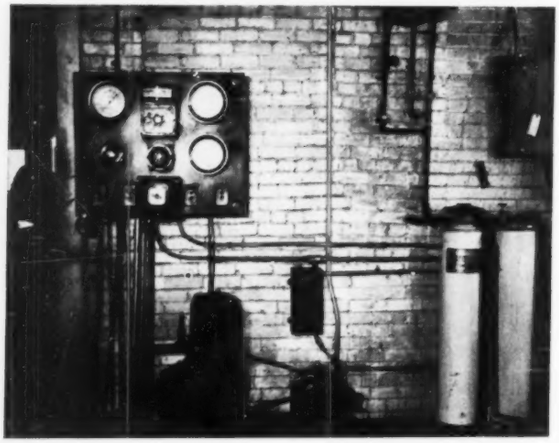






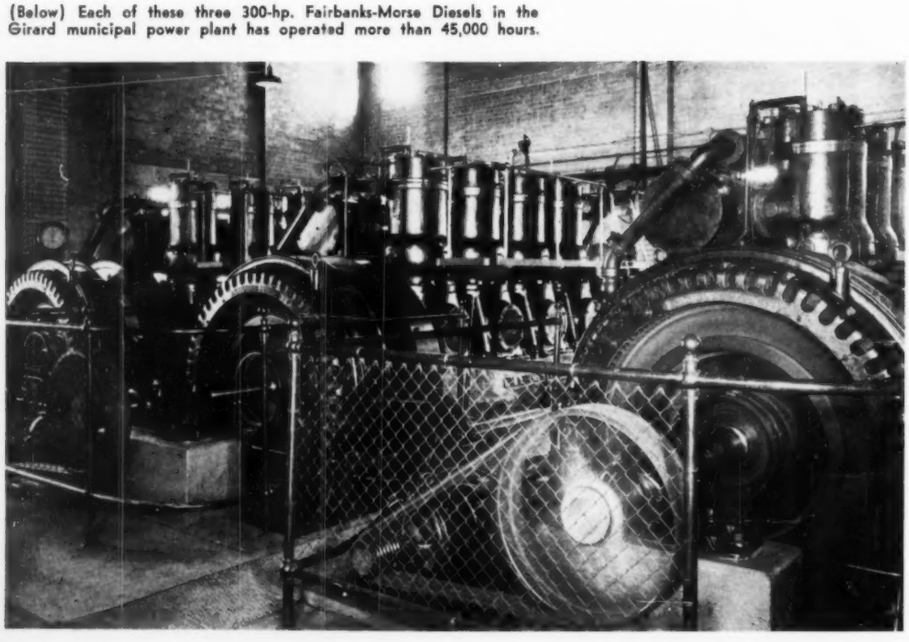
The Girard plant (rear view). Engine air is drawn through Air Maze multimaze filters for each unit. Exhaust gases vent through Maxim silencers and a Burgess snubber.

(Above right) 300 g.p.m. pumps circulate jacket water through the engines and the Sims and Schutte Koerting heat exchangers.



(Above) The alarm panel holds Marshalltown pressure gauges and Minneapolis-Honeywell thermometers. Brown and Alnor exhaust pyrometers. At right is Permutit softener.

(Below) Each of these three 300-hp. Fairbanks-Morse Diesels in the Girard municipal power plant has operated more than 45,000 hours.



# TEN DIESEL YEARS AT GIRARD, PENNSYLVANIA

*By* WILLIAM H. GOTTLIEB

FOUR Diesel engines in the ten-year-old Girard, Pennsylvania municipal power plant have been in operation for a combined total of more than 180,000 engine hours without a single engine failure. A fifth unit, installed in 1947, already has added 2,000 hours to this record. Each of the four older engines has run more than 45,000 hours and generated in excess of 5,500,000 kilowatt-hours. Three of these units are still operating with their original piston rings. Yet, far from showing signs of decreasing efficiency, these prime movers made 1946 the outstanding period in the ten-year life of the plant, producing more than 3,000,000 kw. hrs. at a rate of 12.04 kw. hrs. per gallon of fuel consumed.

Table I

| Year | Net KWH to line | Cost of fuel oil | Cost of Lube Oil | Labor | Maint. & Repairs | Supplies & Miscell. | Totals | Cost Per Net KWH |
|---|---|---|---|---|---|---|---|---|
| 1937 | 1,175,300 | $ 5,681.78 | $ 711.53 | $ 4,060.20 | $ 13.30 | $ 116.89 | $ 10,583.70 | $.0090 |
| 1938 | 1,464,410 | 6,531.07 | 715.13 | 5,089.50 | 243.90 | 240.00 | 12,819.60 | .0087 |
| 1939 | 1,639,450 | 7,340.18 | 657.61 | 5,206.54 | 234.77 | 174.87 | 13,613.97 | .0083 |
| 1940 | 1,873,986 | 7,752.87 | 745.85 | 5,490.00 | 737.55 | 252.14 | 14,978.41 | .0079 |
| 1941 | 2,207,920 | 11,319.53 | 850.98 | 5,706.60 | 305.26 | 184.44 | 18,366.81 | .0083 |
| 1942 | 2,109,030 | 11,559.39 | 772.12 | 6,315.60 | 734.45 | 184.14 | 19,565.70 | .0092 |
| 1943 | 1,991,650 | 12,535.94 | 816.46 | 7,371.60 | 614.83 | 183.67 | 21,522.50 | .0107 |
| 1944 | 2,231,405 | 14,550.73 | 880.61 | 7,667.24 | 685.75 | 149.88 | 23,934.21 | .0107 |
| 1945 | 2,392,340 | 14,968.98 | 935.31 | 7,662.60 | 544.11 | 182.51 | 24,293.41 | .0101 |
| 1946 | 3,012,920 | 18,363.52 | 1,078.50 | 9,115.40 | 578.23 | 323.18 | 29,458.83 | .0097 |
| 10 year totals | 20,097,411 | $110,603.99 | $8,164.10 | $63,685.28 | $4,692.15 | $1,991.72 | $189.137.24 | $.0094 |

Plant efficiency converts directly into dollars, and Girard calculates a clear net saving of $64,902.84 as a result of its Diesel operations. This is a cash dividend over and above the cost of the entire plant which has been paid off out of earnings. The Diesels are all identical Fairbanks-Morse engines rated at 300 hp. at 300 rpm. Each is direct-connected to a 200 kw., 3-phase, 60 cycle, 2400 volt Fairbanks-Morse alternator with v-belted exciter.

The Borough of Girard long has considered it a municipal function to provide its citizens with power and light. In 1900, the community erected a modest network of transmission lines and a small steam plant to supply the current. The plant was run only from sunset to midnight; no one in Girard then required lights after the witching hour. Nineteen years later, expanding demands for electricity threatened to outstrip the capacity of the plant and the private utility in the district was able to offer a rate which compared favorably with operating costs of the relatively inefficient steam engine. Girard retained and enlarged its transmission system but purchased utility power at bulk rates.

By 1936, although the cost of purchased power had been reduced to 18.2 mills per kw. hr., Borough Engineer Harold Duff and other civic officials calculated that they could produce their own power at a substantial saving. The voters were consulted and supported their officials' judgment by voting a bond issue for the purchase of generating equipment. On March 14, 1937, the first two Fairbanks-Morse Diesels went into operation. Within a year, the extent of the savings were evident, for production costs were only 9 mills per kw. hr. A third engine went into operation on October 1, 1938, and a fourth on August 1, 1941. Load and production climbed steadily and costs, already satisfactory, went lower still.

The war put an artificial ceiling on the consumption of electricity and peak loads actually declined from a high of 592 kw. in 1941 to 480 kw. in 1943. Perhaps it was just as well, for additional engines were unobtainable. During the later war years, the Diesels met the ultimate test of economy. With sales held down and all costs pushed skyward by general inflationary pressure, if ever the plant was to go in the red, the time had come. Yet, the peak cost per kw. hr. was still 7.5 mills lower than the cost of purchased power.

When the ceiling came off, demand shot up with renewed vigor, reaching 675 kw. in 1945 and 780 kw. in 1946. The answer, of course, was more F-M Diesels and the fifth unit went to service on February 1, 1947. Prices are higher than ever but the solution to that problem, in the power plant as in all industry, is more and more production. In 1946, the cost of producing a kilowatt-hour was again only 9.7 mills and a further reduction is in prospect for 1947.

Table I gives a year by year picture of operating costs for the first ten years of the plant's life. Table II gives the annual data on plant efficiency expressed in consumption of fuel and lubricating oil. The record is truly impressive.

The reader is cautioned in making cost comparisons between power plants to include all legitimate elements of expense. The figures on Girard's savings are based on complete costs, including all plant operating expenditures, interest, taxes, and the full amortization of the plant purchase price within the ten-year period. This is highly conservative for depreciation usually is figured over 20 years. Furthermore, all comparisons with the cost of purchased power are based on net kw. hrs. delivered to the line, the same number of kw. hrs. the borough would have had to buy and pay for if the diesel plant had not been in operation.

Here, in concrete terms, is what Diesel economy has done for Girard: Citizens of the borough pay only token taxes amounting to a total of less than $5,000 a year. Power plant earnings pay all the rest of the expenses of government and public improvements. From this source came the money to pay off $15,000 of sewage disposal bonds, and funds will be available to meet a $22,000 bill for new sewers. Property for a projected new municipal building was purchased at a cost of $12,500. Every year, an average of $2,500 is contributed for street paving. Street lighting also is a gift from the power plant.

The record achieved at Girard in ten years could come only from equipment carefully chosen and competently operated. The heavy-duty Fairbanks-Morse Diesels are of the two-cycle crankcase-scavenging design. Fuel feed to the engines is regulated to meet varying load by individual Type IC Woodward governors. The No. 3 fuel oil is unloaded by gravity into two 10,000-gal. underground storage tanks from which it is pumped by a motor-driven 1-in. internal gear F-M transfer pump through a Niagara meter to individual day tanks for each engine. The day tanks too are under ground and fuel is drawn from them through filters by pumps built into the engines. The Diesels are lubricated with Texaco Algol.

The cooling water system is flexible and affords the engines maximum protection. All water for the entire community as well as the plant is supplied by three F-M well pumps. Engine jacket water is treated in a Permutit softener and circulated through the engines and the tubes of two heat-exchangers (a Sims and a Schutte-Koerting) by two 300 gpm. Fairbanks-Morse contrifugal pumps driven directly by 5-hp. F-M induction motors. Another pair of identical pumps send raw water through the exchanger shells, a Marley atmospheric cooling tower, and a Yates-American

Table II

| Year | Gross KWH Generated | Gals. Fuel | Gals. Lube | KWH per gal. fuel |
|---|---|---|---|---|
| 1937 | 1,244,200 | 106,273 | 1,387 | 11.70 |
| 1938 | 1,551,000 | 129,624 | 1,510 | 11.96 |
| 1939 | 1,725,200 | 145,837 | 1,552 | 11.83 |
| 1940 | 1,972,200 | 165,579 | 1,835 | 11.91 |
| 1941 | 2,326,900 | 195,843 | 2,093 | 11.88 |
| 1942 | 2,242,500 | 188,126 | 1,862 | 11.92 |
| 1943 | 2,140,000 | 181,461 | 1,921 | 11.73 |
| 1944 | 2,377,000 | 198,270 | 2,072 | 11.98 |
| 1945 | 2,559,600 | 213,626 | 2,178 | 11.98 |
| 1946 | 3,196,500 | 265,444 | 2,543 | 12.04 |
| 10 year totals | 21,335,300 | 1,790,084 | 18,953 | 11.92 |

radiator. The plant is so arranged that the tower and radiator can be used singly or together. Similarly, either or both heat exchangers can be used with any combination of engines. A fifth pump has been ordered to provide added standby protection. The radiator is used almost continuously in cold weather so that waste heat may be employed to heat the building.

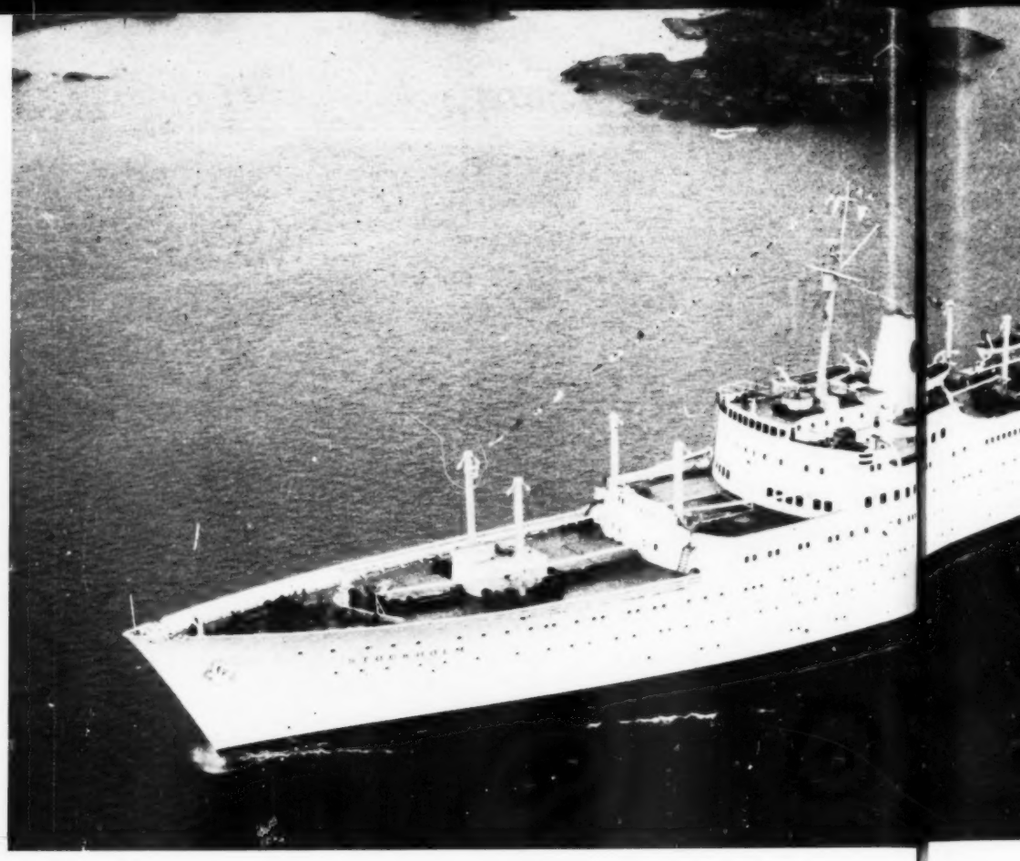
An alarm panel, with Marshalltown pressure gauges and Minneapolis-Honeywell thermometers warns the operator if jacket water temperature goes above 140 deg. F. or if soft or raw water pressure drops below the prescribed minimums. Exhaust temperature at every cylinder can be checked by means of the multipoint Alnor and Brown pyrometers. Included on the 10-panel Allis-Chalmers switchboard are A-C voltage regulators and Westinghouse Watt-hour meters and recording meters.

Engine air is drawn from outside the plant through Air Maze multimaze filters for each unit. Exhaust gases for all but the No. 4 engine vent through Maxim silencers. The No. 4 units has a Burgess snubber. All the Diesels are started by compressed air supplied by a Fairbanks-Morse compressor.

The plant is run by three operators on 8-hour shifts under the general supervision of the borough engineer. The men do all maintenance work themselves except for the changing of a main bearing.

# STOCKHOLM

## Sweden's Newest Passenger Ship Has Diesel Drive



*By* BRUCE C. SISSON

THREE golden crowns on a blue shield decorate the funnel of the new liner *Stockholm*. It is the insignia of the Swedish American Line, which has long served as a friendly connecting link between Scandinavia and America. The line is proud of the *Stockholm* and rightly so, for she is a beautiful ship.

In October 1944 when the allied armies were moving towards victory, the Swedish American line placed an order with the Gotaverken shipyard of Gothenburg for the largest passenger liner ever to be built in Sweden. She was not to be of the "super-liner" class, but her designed lines were to make her an outstanding example of gracefulness and speed for vessels of her class.

She was launched in September 1946 and during the year following was completely outfitted for trans-Atlantic passenger and cargo service. The *Stockholm* is 525 feet overall with a maximum beam of 69 feet. Her draft is 24 feet, 9 inches when fully loaded. Her displacement is 13,000 tons and she will carry 3,000 tons of cargo. She will accommodate 395 passengers, all in outside staterooms.

In appearance, the *Stockholm* differs materially from the conventional type. Her lines are sleek and modern, with modern streamlining being incorporated in the hull and superstructure. She has a raking stem with "soft nose" and a long after-body with a cruiser stern. The single mast is another departure from the traditional. In order to ensure the most efficient hull form, comprehensive model tests were made in the Government experimental tank before dtermining the lines of the vessel. Rolling tests were also carried out in order to find out the influence of the bilge-keels upon the movements of the vessel at sea.

The ship's power plant is not the least of the attractions aboard. The engine room including the main engines and auxiliary equipment is light green in color, making for good lighting. The main engine room houses the two propulsion Diesels which develop about 6400 bhp. apiece at 110 rpm. They are 8-cylinder, 2-stroke, single-acting, crosshead Diesels of Gotaverken manufacture. They are the largest engines that have been built in Sweden and have a bore of 760 mm. (30 inches) and a stroke of 1300 mm. The main engine room is equipped with a complete machine shop with lathe, drill press and other associated equipment. On the port side are located the oil centrifuges, pumps, compressors and other auxiliary equipment.

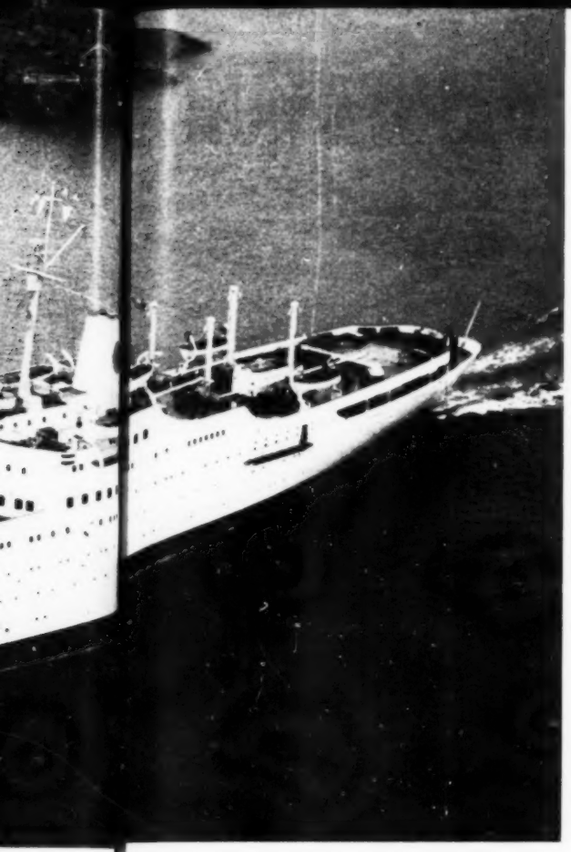
Forward of the main engine room is the auxiliary engine room which houses the auxiliary Diesels, boilers and evaporators. This steam generating equipment, by the way, is aided considerably by the installation of an exhaust gas boiler with a heating surface of 200 sq. meters and a working-pressure of 100 lbs. psi. The auxiliary Diesels include five single-acting 4-stroke engines—three 6-cylinder and two 3-cylinder developing 360 and 180 bhp. at 350 rpm. respectively. They drive 240 and 120 kilowatt generators. The auxiliary Diesels are also of Gotaverken manufacture. The evaporator plant has a capacity of 40 tons of fresh water daily.

For heating and ventilation of the vessel great care has been taken. The engine rooms alone are furnished 140,000 cubic meters of air per hour by seven centrifugal fans. For the living spaces there are 27 air conditioning units capable of handling 100,000 cubic meters per hour. Conditoned air is supplied to the cabins through a double duct system, one supplying warm air, the other, air at a lower temperature. This allows passengers control over room temperature. The saloons have automatically controlled temperatures and are evenly heated by warm air entering through overhead ducts. For exhausting air from the compartments of the ship, 23 exhaust fans are installed with a capacity of 86,000 cubic meters per hour.

Extensive fire protection equipment is installed aboard the *Stockholm*. The engine room installation is of particular interest. The protection is provided by a Kidde carbon dioxide system comprising 39 45-kilo bottles fitted with quick opening valves. The control station containing the stop valves and release boxes is located close by the main engine room hatch on C-deck. The $CO_2$ piping leads down into the engine rooms where outlets are located in strategic places. In addition to the extensive $CO_2$ system there is a complete foam extinguishing installation consisting of three foam hydrants connected to a foam-making unit operating with compressed air and carrying a tank containing 700 litres of a foam liquid and water mixture. The installation develops a total foam capacity of 22,000 litres per minute.

The *Stockholm* is equipped to handle 22,000 cubic feet of refrigerated cargo in three rooms. The rooms can be cooled independently of each other to different temperatures down to 0° F. Freon-12 is used as a refrigerant and three 34-hp. compressors handle it, although only two are required to operate at one time.

Passenger accommodation has been arranged in two classes, first and tourist. The two dining



*Stockholm*, 525-ft cargo-passenger liner of Swedish American Line on her trial trip.

(Above) First Class lounge of *Stockholm* is tastefully decorated and comfortable.

(Below) Tops of main Diesels which develop 6400 bhp at 110 rpm. They are 8-cylinder 2-cycle, crosshead engines of Gotaverken make.

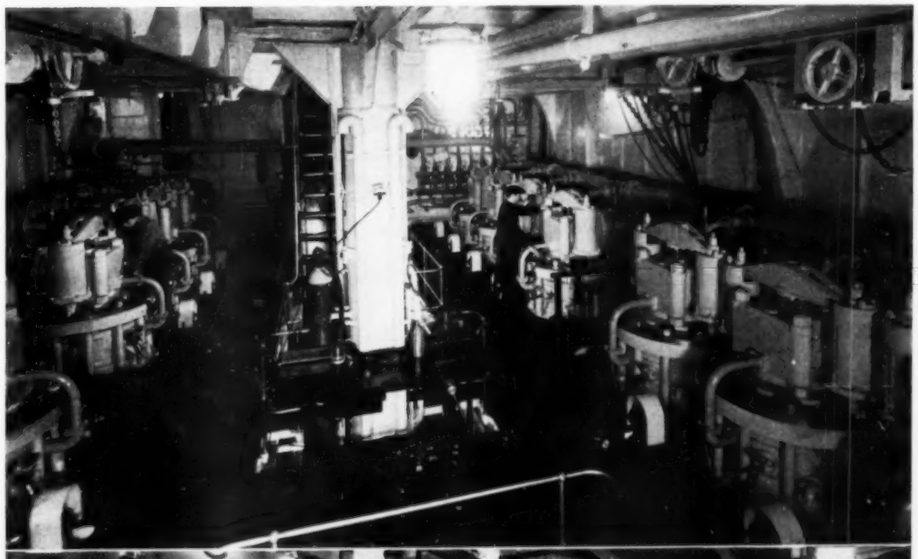
(Bottom) View of auxiliary engine room showing switchboard and auxiliary Diesels. 1080 kw. is available to drive ship's auxiliary equipment.

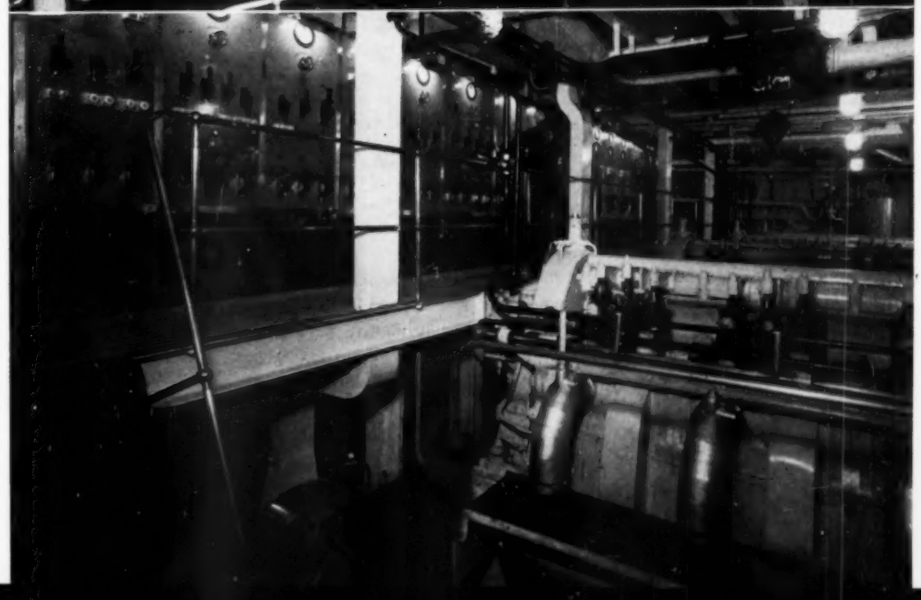
saloons are situated on the same deck and adjoin one another. Comfort, rather than luxury is the key note of the new *Stockholm*. More stress has been placed on air and light in the form of outside staterooms and modern design than upon elaborate decoration. Nevertheless all the appointments found on larger ships are present up to and including a swimming pool, turkish bath and florist shop.

The main deck decorations are truly outstanding, with many original murals and woodcarvings tastefully arranged in the public rooms.

Once again Europe shipowners have produced an outstanding creation—and it is Diesel engined.

The radio communication equipment on the *Stockholm* is formed for greatest ability. After having discussed a number of different alternatives, the radio station was equipped with three separate transmitters providing telegraphy and phone. In order to get the most effective radio telephony performance, the transmitters have high power modulators. Further more there is a separate emergency installation in accordance with the Safety of Life at Sea Convention. Two life-boats have their own radio stations. The main transmitters, which are crystal-controlled, have the antenna power of 300 watts. The frequency range is 375 kc./s—17 Mc/s (800 meters to 18 meters). The radio cabin has two places for operation from which all transmitters may be operated. As the ship has two transmitting antennas, it is possible to work two frequencies simultaneously. There are four communication receivers, two for long-wave and two for short-wave, providing comfortable "stand by" on four frequencies if necessary. The receiving antenna is placed astern away from the transmitters and their antennas.





# MODERN DIESEL LOCOMOTIVE MAINTENANCE

*By* FRED M. BURT

*Operations in Santa Fe Railway's diesel super service stations that keep the Super Chief's 6000 hp. diesel locomotives in prime running condition.*

ONCE an outfitting point for Death Valley expeditions, and a desert junction for overland wagon trains, the little town of Barstow, Calif., in 1947, became the principal repair point for diesel locomotives on the Santa Fe Railway.

The new diesel servicing shop built in 1945, for maintenance and running repairs on the huge, new 5400 hp. diesel freight locomotives, built by the Electro-Motive Division of General Motors, became inadequate with the increased use of diesel locomotives on high-speed passenger trains. With most of the line's freight and passenger diesels already moving through Barstow, plus the Super Chief and the El Capitan going into daily service February 29, 1948, these shops have become an extremely busy maintenance point.

In order to meet these increased demands, a new extension was built, 75 ft. wide and 225 ft. long, with structural steel frame 48 ft. high, corrugated transite sides, steel rolling doors, and a built-up asbestos roof. Facilities include three concrete inspection pits 220 ft. long, with standard gauge track running the full length, and an electric crane 70 ft. long with a five-ton auxiliary hook.

A diesel truck transfer table is used to remove four- and six-wheel trucks, and there is a support to hold locomotive unit bodies while the trucks are being removed. Dismantling and reassembling of trucks and minor repairs to traction motors is done here for switchers as well as for passenger and freight locomotives and the space is also available for running repairs.

Inspection pits in the new addition are complete with fluorescent lights and service pipe lines for raw water, distilled water, steam, air, lubricating oil, reclaimed distilled water, and fire lines.

Barstow's shops are responsible for the maintenance of more than 80 diesel locomotives, most of which are in road service. All passenger diesels operating between Los Angeles and Chicago, and all Coast Lines territory diesel freight locomotives are maintained here.

Diesels on transcontinental passenger runs travel 2080 miles from Chicago to Barstow, where there is an 8-12 hour layover for inspection and servicing. The next leg of the trip takes them 147 miles from Barstow to Los Angeles, where diesels are tuned in a few hours before making the long jump to Chicago. After 12 hours' layover there, the same cycle repeated.

Mileage inspections are made on passenger locomotives in the following sequence: trip, 10,000-mile (approximates semi-monthly), monthly, quarterly, semi-annual, and annual. Freight diesel locomotive inspections include trip, 3,500-mile, 10,000-mile (approximates monthly), quarterly and semi-annually. All annuals are made at San Bernardino.

Handling the big diesels through Barstow's shops is a systematic and speedy procedure, with the average time for giving a 4-unit General Motors locomotive a trip inspection in less than 30 minutes.

When the Super Chief pulls into Barstow from Chicago, its locomotive is cut off and run through the yards by a hostler, to a double-track cleaning and fueling platform, 270 ft. long, capable of servicing two complete freight and passenger locomotives at one time.

This platform is supplied by underground pipelines, with water for washing, distilled radiator water (from a 20,000 gallon storage tank which in turn is supplied by a 500 gpm. distillation plant) and fuel. The fuel is pumped from eight suspended hose lines capable of fueling two complete locomotives in three or four minutes; for each a maximum of 5400 gallons of fuel oil, a maximum of 3400 gallons of water in the tanks for the steam generator; also sand for its "side pockets" to be used to sand rails on grades.

An average of a little more than 50,000 gallons of fuel oil is used daily at Barstow, plus an average of upwards of 45,000 gallons of lubricating oil per month. To handle this great volume of fuel oil, there is a storage tank of 2,311,055 gallons. There are also three 15,000 gal. lubricating oil tanks, two for new oil, one for salvage oil which is reclaimed at Topeka and used again.

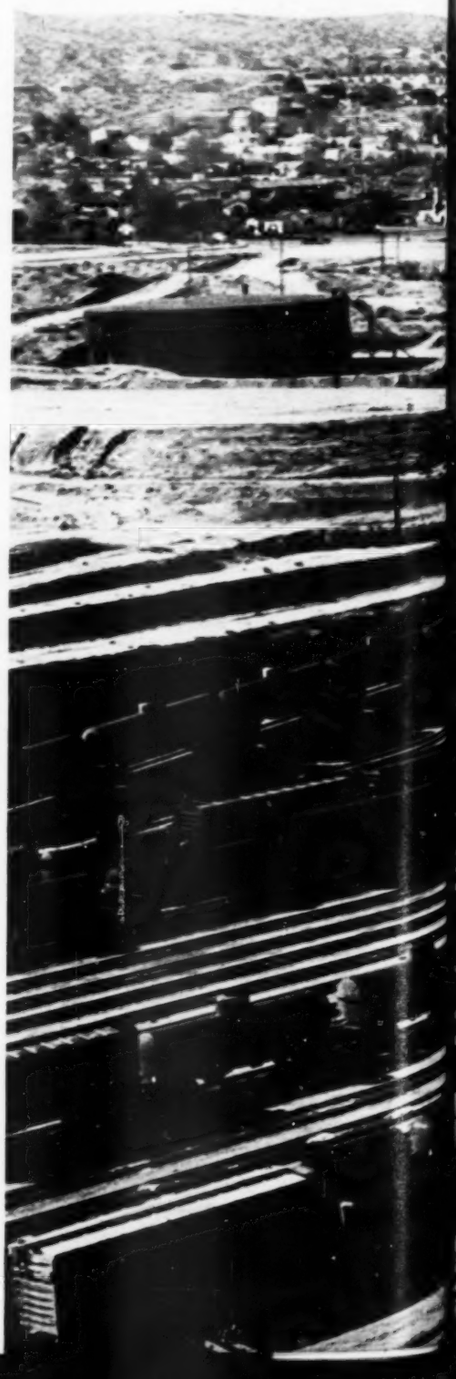
Here also, a cleaning solution is sprayed all over the locomotive and then brushed over, to soften the dirt and oil. Then the locomotive passes through a wash rack rinsing, the whole cleaning operation requiring only about fifteen minutes.

Next the locomotive moves to Track 1 in the diesel house, which, when constructed in 1945 was the first facility of its size and kind in the world. The building is 138 ft. wide x 250 ft. long, with six tracks inside, each capable of taking a full, four-unit freight locomotive 194¼ ft. long. The remainder of the interior space at the rear of the building is used for supervisory personnel offices, for the store department, and for cleaning and repair shops.

The main floor of the structure is of depressed construction, 3½ ft. below rail top, with ramps at engine door level, seven feet above the floor. This depressed floor adds ease to inspection of wheels, brake shoes, brake levers, truck frame and under portion of unit body, also inspection and cleaning of traction motors. Pits and floors on this level are open to the basement at both ends. Banks of fluorescent lights under the ramps give daylight brightness.

With the exception of traction motors and wheels, changed at San Bernardino, Winslow, or Chicago, a replacement for every type of diesel locomotive part is available in the store department, about 4,000 items. These are used to replace parts found imperfect on inspection. The latter are routed through dis-assembly, cleaning, and then repair before going back into stock for future use.

After the big diesel is inspected in the diesel shop, mechanics go to work. In the power plant, the machinist lowers sections of the cat walk that he might stand on them for top deck mechanism



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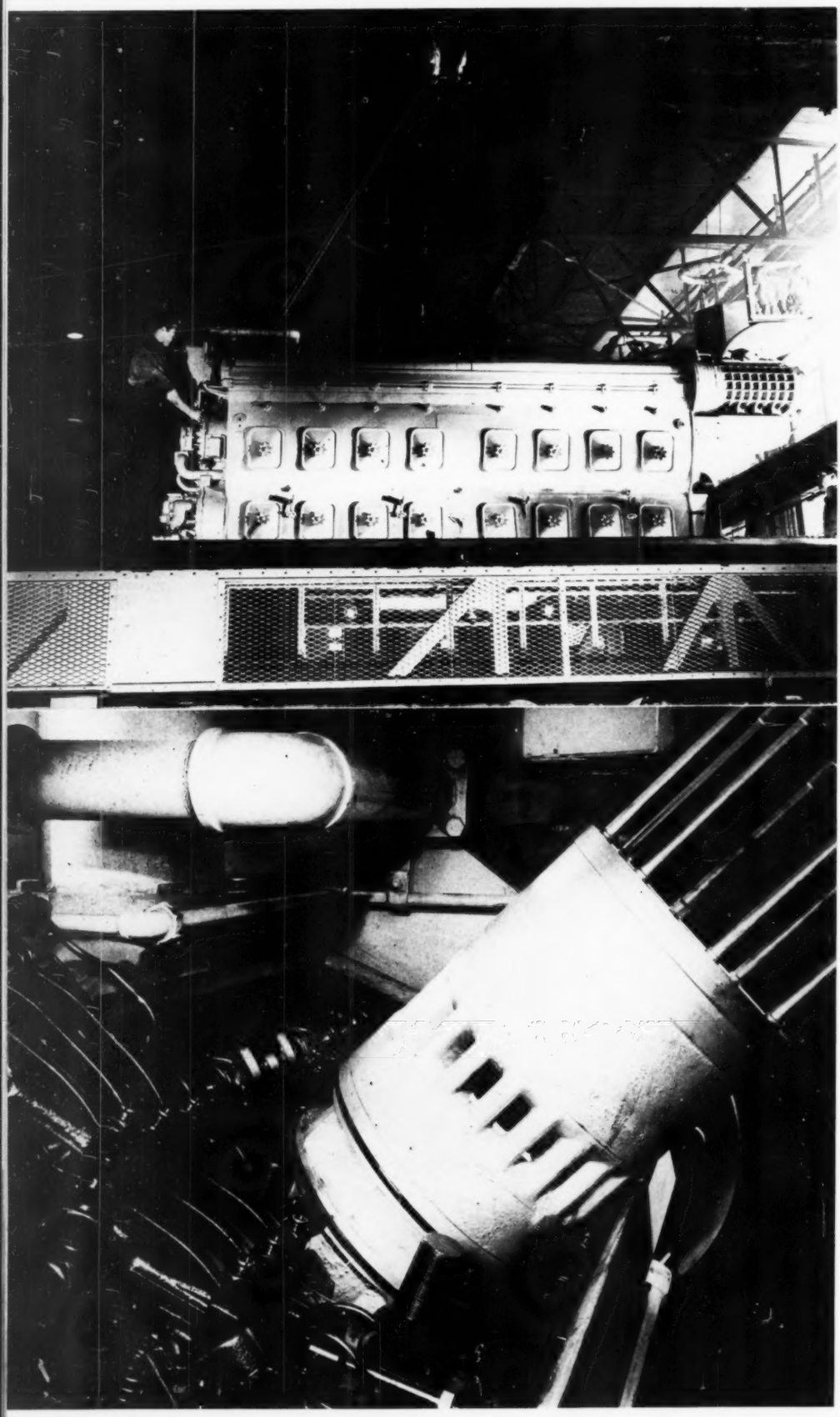
## *Santa Fe's Barstow shops completely equipped for Service and Repair operations*


Two Santa Fe diesel-electrics outside of Barstow shop.

View of Barstow, Cal. with Santa Fe yards and diesel shop predominating. Note diesels at service rack in center.

Santa Fe machinists assist in lowering overhauled General Motors diesel into cab at San Bernardino shops. (bottom) General Motors liner assembly ready for installation in diesed engine at Barstow shop.



inspection. He removes covers and carefully checks the lash adjusters while the engine runs at idle speed. From this inspection he makes a report of conditions found and repairs needed.

The engine is then shut down and air-box and crankcase covers removed for checking of liners for water leaks, rings of pistons, general condition of piston assembly; also for inspection of crankcase, connecting rod bearings and assemblies in lower portion of engine. All defective parts are removed for replacement and repair.

A head puller is used to break the head loose. Then it is lifted out and sent to the repair shop. The piston assembly is removed and the liner is pulled out. Then the lower water manifold seal seats and general assembly are inspected and cleaned.

Meanwhile electricians examine the diesel's electrical equipment, both generator and auxiliary generator.

At the high voltage cabinet, the electrician inspects the ground relay knife switch, the ground relay, the wheel slip relay contacts, the generator shunt field contactors, and the parallel relay, for their condition and operation.

In the steam generator inspection, the switch is turned to the "Fill" position, the inspector observing whether the water pump is furnishing sufficient water. When the steam generator is filled, the switch is turned to the "Run" position and, if the generator is functioning properly, the steam gauge of the separator indicates 225 pounds in a matter of 30 to 60 seconds.

Defective heads, governors, injectors and other such parts go to the repair department. Repaired governors are secured to the rack for testing before being put back into use. The air that drives the mechanism of the governor test rack is turned on, and the speed at which the spindle operates is checked with a tachometer. Movement of the piston indicates that the governor is hunting, and a correction is made at the needle valve adjustment.

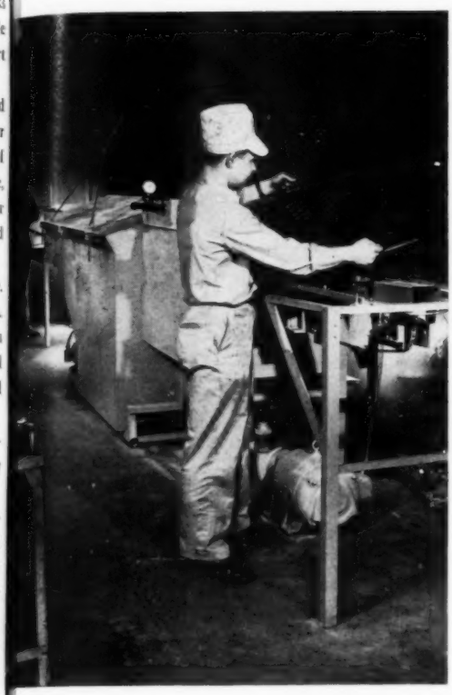
Fuel injectors are tested on a Buda test rack.

Worn valves and seats are placed in the spindle of a grinder and revolved against an abrasive wheel at high speed to true and polish the face.

Fuel, lubricating oil, and even the air in the diesel locomotives is carefully filtered to eliminate grit and dust. Fuel oil is filtered going to the locomotive and then passes through three filters before reaching the motor. Oil filters are cleaned with successive baths of alkaline water and steam jets, and are then repacked with new filter material. Dirty air intake or car body filters are placed on a conveyor, passing through a pre-rinse and a geyser of cleaning solution. Then they go to a "centrifuge oiler" where, in a matter of minutes, the filter is evenly coated with lubricating oil so as to properly filter all air passing through.

The dispatcher's board at Barstow is an efficient aid to this maintenance system. It indicates the engine number, the time it is due to arrive, from what direction it is coming, actual arriving time, type of inspection due, time the locomotive is again ready for service, and the subsequent direction of movement.

With completion of the inspections, servicing, and repair work, which has only been high-lighted in the foregoing, the diesel locomotive is again ready to be on its way for almost 5000 miles of



(Above) L. Blackburn tests General Motors unit fuel injector on Buda test rack at Barstow shops.

(Above) Machinist Rahn assembles overhauled diesel engine governor.

(Above, left) Cleaning dirty air filters at Barstow shop. Filters are placed on conveyor and passed through cleaners. Filters are of Farr manufacture.

(Below) Diesel fueling platform at Barstow has facilities for fueling two complete locomotives in three or four minutes.

service before its return to Barstow for this particular type of service.

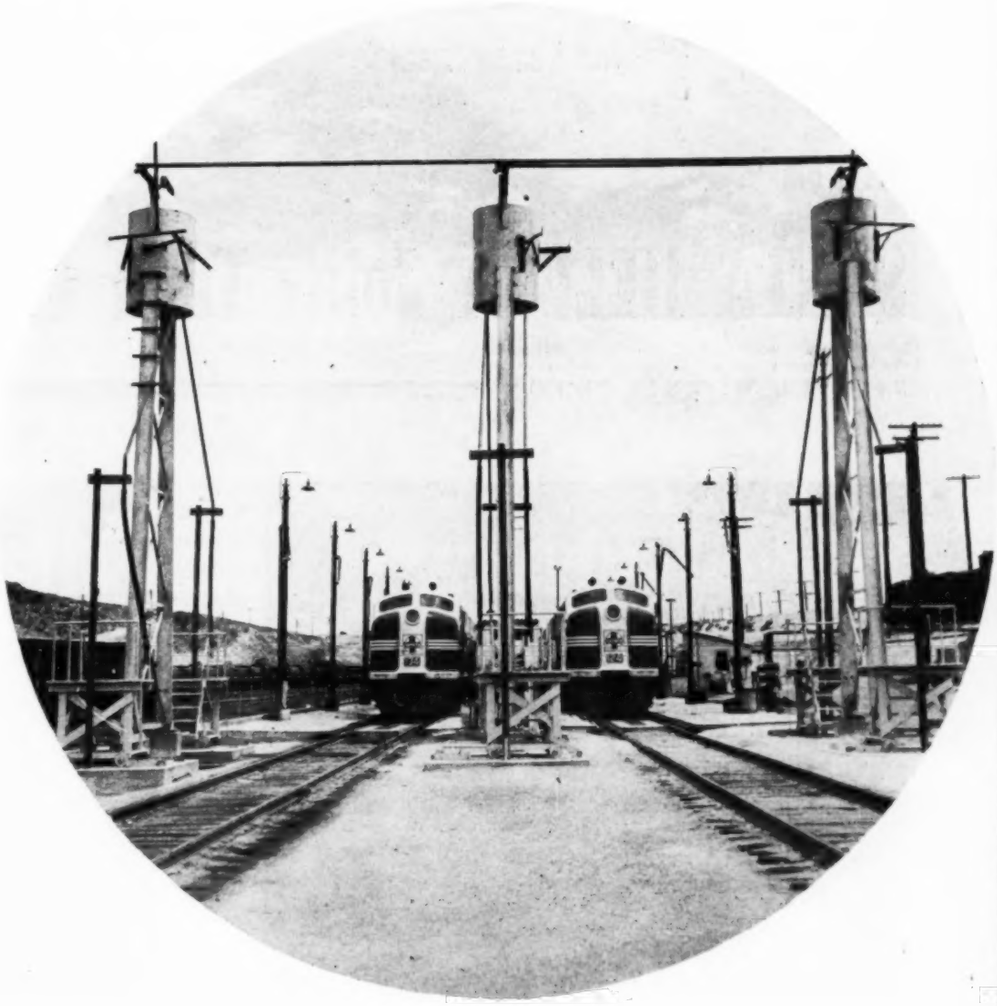
When an engine requires heavy repairs or complete overhaul, the roof hatch is removed and a heavy crane lifts out the diesel power plant, moving it to the engine bay for dismantling. A boring bar designed and built in the Santa Fe shops is applied to the "A" frame. The main bearing caps are bolted into position and the fit is bored out to the original standard dimensions.

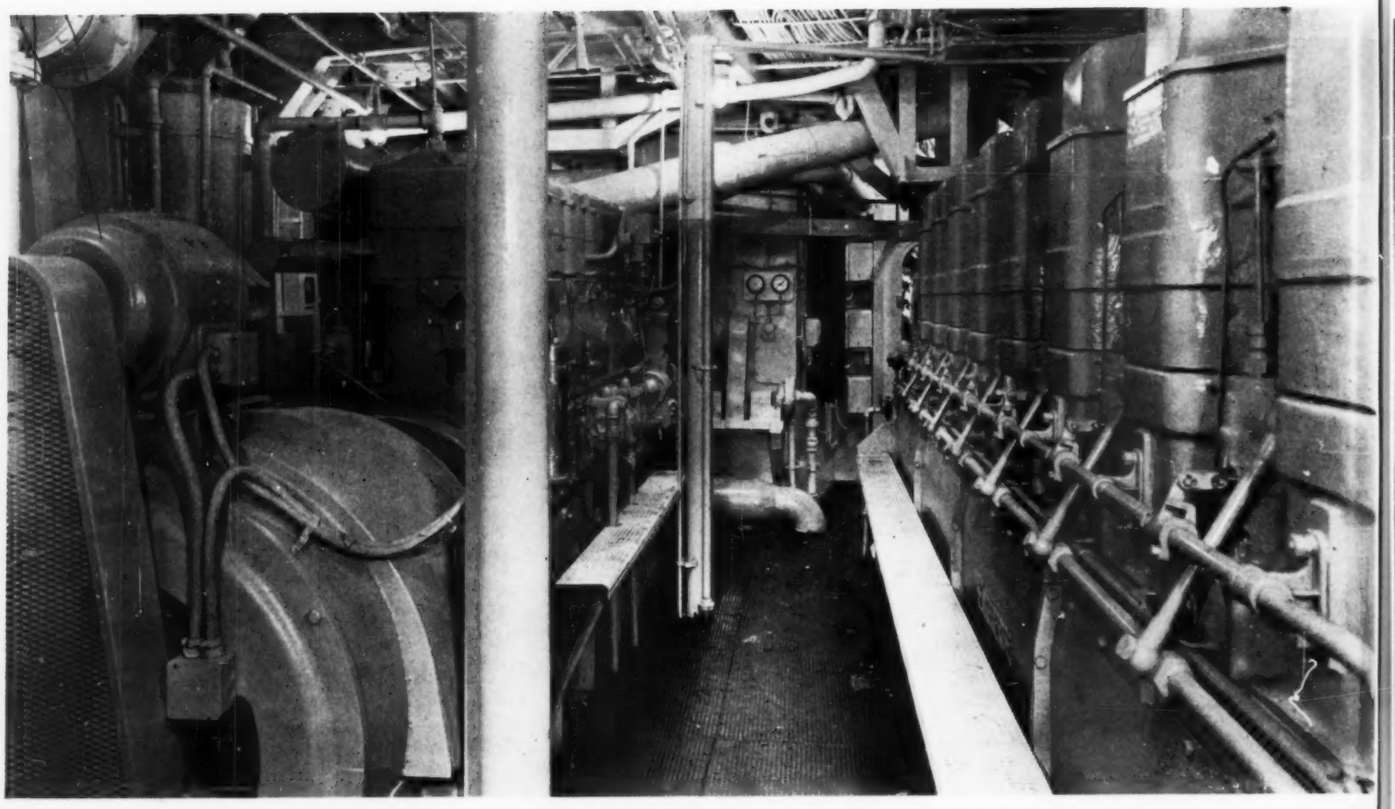
If damage has been done to the lower deck of the engine, it is sometimes necessary to weld the lower liner seal seats. The seats are machined to their proper dimensions. The engine frame is painted inside and out before being placed on the line for reassembling.

Gaskets are put into position and the parts that have been repaired at the bench are then replaced. After the engine has been completely reassembled in the engine bay, it is picked up by the crane and reapplied to the unit. After it has been secured to its foundation, and connected to the main generators, the unit is again ready for service.

The daily Super Chief, leaving Los Angeles at 8 P.M. and arriving in Chicago 39¾ hrs. later, or at 1:45 the second afternoon; leaving Chicago at 7 P.M. and arriving in Los Angeles the second morning at 8:45, is an all-room train. These range from roomettes for individuals to drawing-room-bedroom suites to provide spacious accommodations for family or other groups.

The electronic equipment makes available a radio channel, popular and semi-classical music, and a public address system in the lounge and room accommodations throughout the train. The dining car is equipped with a sufficient number of speakers installed in the ceiling that appropriate music may be provided through an even distribution of low-level sound that will not interfere with conversations, yet loud enough to be heard and enjoyed.





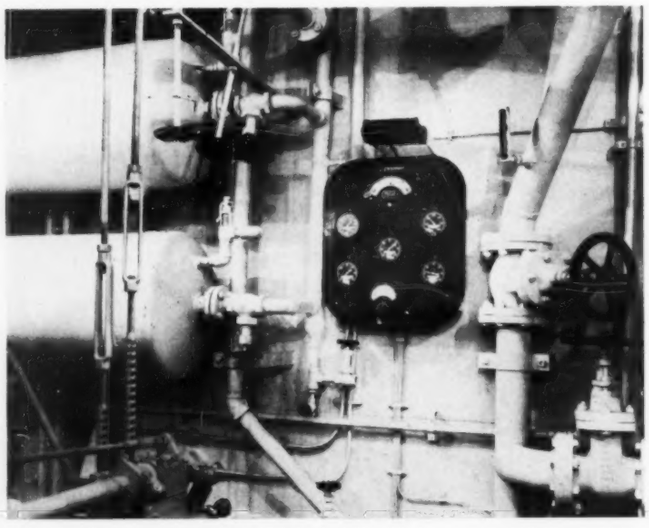
Engine room, looking aft; showing starboard side of propulsion engine 1050 hp. Enterprise diesel, and the starboard Atlas generating set.

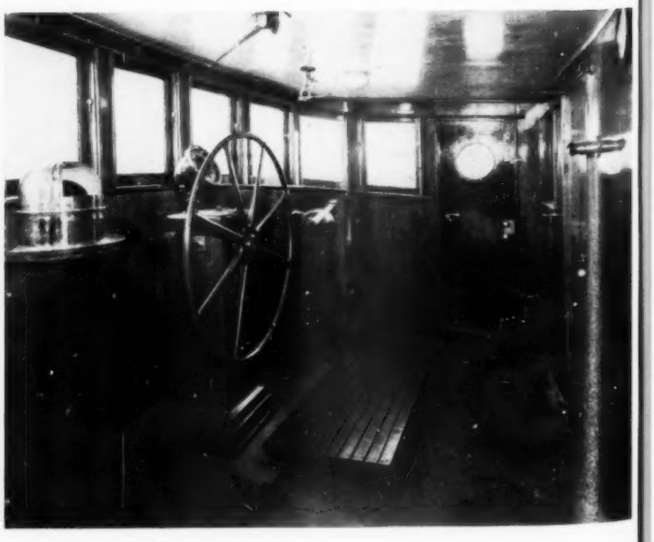
(Below) Gauge board, with Weston Tachometer and Alnor Pyrometer dials.

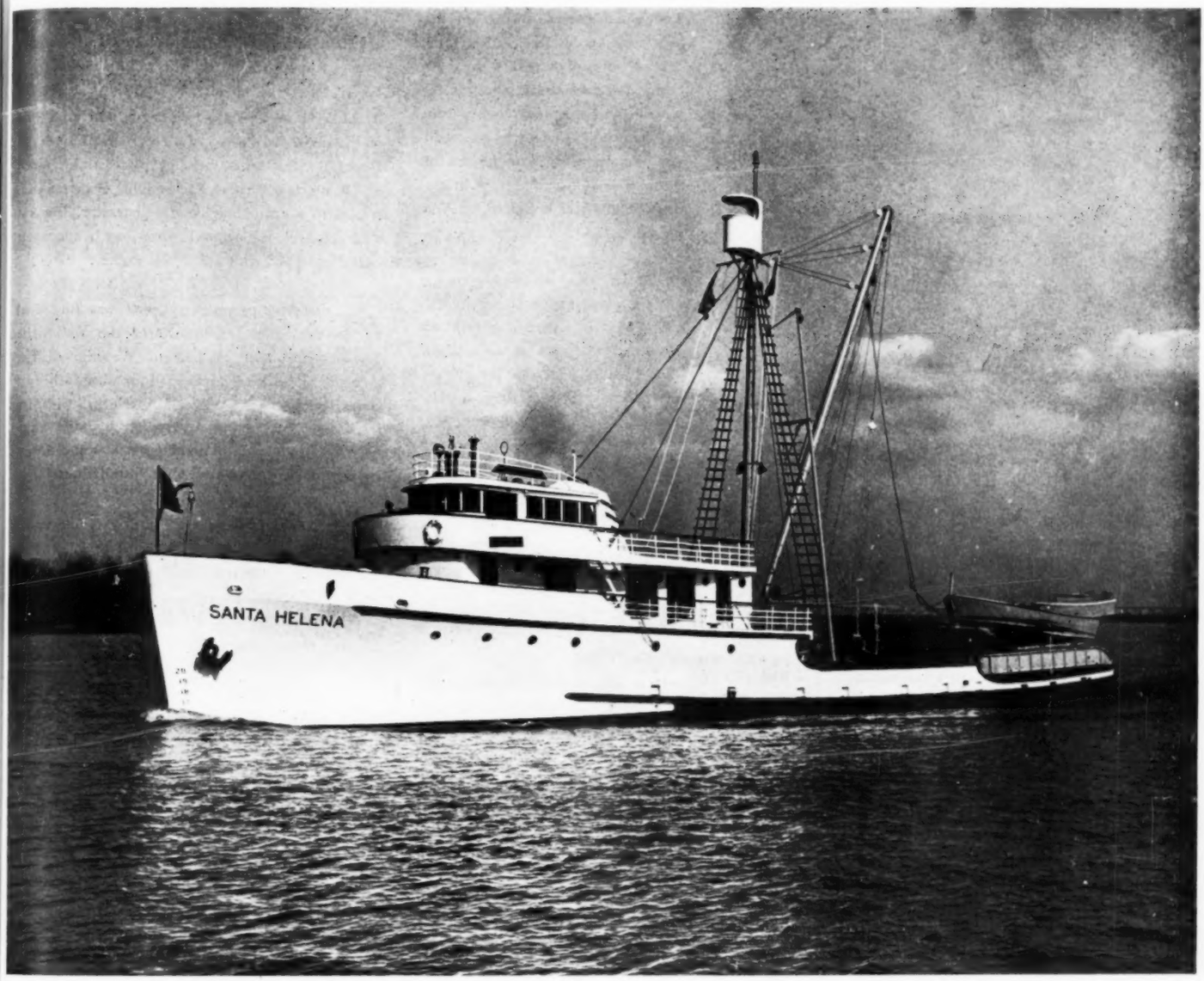
(Below) Pilot-house, showing Sperry steering stand and Gyrorepeater.

# SANTA HELENA Joins Tuna Fleets

*By* WILL H. FULLERTON








135½-foot purse seiner *Santa Helena*. Note steel scow-type net-tender carried on the stern, atop the net piled on the turn-table, with smaller boats nested. Crow's nest has a permanent roof.

THAT Diesel engines are powering fishing boats is no news, for this type of power is probably driving more American commercial fishing vessels of forty feet overall length and up than all other kinds of power put together. However, every so often there comes along a vessel for the fishing industry which is news rather than run-of-the-mill, either because of size, application of power, type of operations or other good and sufficient reasons.

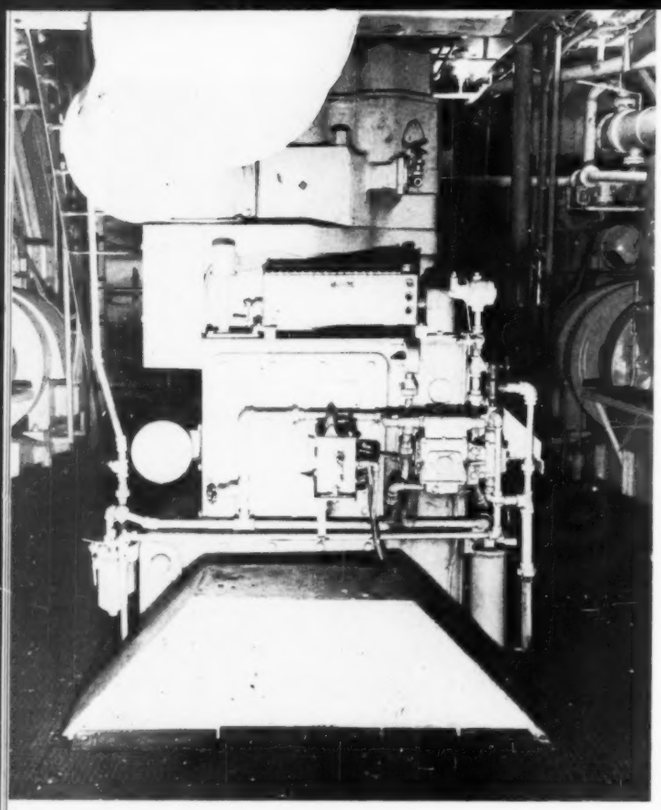
Such a boat is *Santa Helena*. She is unusual in that she typifies a change in trend and is likely a forerunner of things to come.

In case you are not too familiar with tuna fishing procedure, let it be mentioned that most of the tuna caught in the past has been by the hook and line method. While it may seem impossible to catch enough fish one at a time with bamboo poles to fill the millions of cans on the grocers' shelves all over the world, nevertheless such is the case. The fish have been caught this way—and with no bait on the hooks, either.

Tuna boats use live bait, bought in quantity and carefully kept in tanks. When schools of tuna are sighted, this live bait is fed overboard a little at a time, attracting the big fish. On the fishing platforms rigged around the stern of the tuna clipper, fishermen take their stands with heavy bamboo poles with lines using a single hook, shiny and barbless. The bait man keeps feeding the bait overboard, just enough to keep the tuna rushing hungrily about, snapping at everything shiny and moving. It's a case of mistaken identity; they snatch at the streaking glimmer of a shiny hook and are tossed aboard in a hurry, falling off the hook of their own accord and it goes back into the water for another sucker. This is fast fishing.

Tuna are usually of uniform size in a school. They may be small, medium, large, but the chances are that they'll all be the same size. For smaller ones, the fish poles are rigged with one line to a pole; for larger tuna, two, three or four poles may be rigged to a single hook, depending on the size of the fish in the school. This sort of teamwork calls for expert fishermen, but that is the system that puts tuna-fish sandwiches in every drugstore.

Yes, it's fast fishing, but mass production can beat individual effort. In the tuna business, certain thoughtful skippers believed that tuna could be caught with the purse-seine method, just as



Engine room, looking forward; showing rear end of the Enterprise and both Atlas units. Note Manzel lubricators for cylinders and intermediate bearings.

menhaden or sardines are caught every day.

Briefly, a purse-seine is a long strip of webbing, hundreds of feet long, with a width according to the depth of water being fished and the kind of fish being sought. One edge, the top, is fitted with a series of corks or floats; the lower edge is weighted. This long seine is carried by skiffs around a big school of fish and is drawn together. Along the bottom edge is a "puckering string," a line running in steel rings. This line is drawn tight, closing the bottom of the net like an old-fashioned purse, hence the name, purse-seine. And this is quantity fishing.

For tuna, these nets are long, heavy, and have proved workable. There are now well over two hundred purse-seiners in the Pacific tuna fleets and they beat pole-and-line production three to one, it is said. *Santa Helena* is a purse-seiner, the biggest one ever built, and there will be more like her, that's sure.

The purse-seine carried on the turn-table aft is nearly a mile long, with over twelve thousand corks and floats, and cost $45,000. Quite a fish-net! The net-tender boat, instead of being a skiff, is an all-steel scow with a Chrysler gasoline motor of 125 hp. Two skiffs work along with this steel boat; the long net, itself weighing 30 tons, is paid out, the mother ship makes a big circle, and the outfit is ready for gathering in. The purse-line is ¾" steel cable, which gives you an idea. When the net comes back aboard, the net table is turned and takes it in over the side.

That's the system, and as to the boat, she is all-steel, all-welded, 135', 6" overall length with a 30' beam and a 14' draft. She was designed by G. Bruce Newby, who has many tuna designs to his credit and is acknowledged to be one of the best tuna-boat designers in the field. The vessel is classed by ABS for fishing service.

As the cost of a completely equipped tuna boat may well run around half a million dollars, big business often has its place in ownership. With the *Santa Helena*, the owners are partners; one of them is Andrew Zambarlin, of San Francisco, California, a tuna fisherman of thirty-six years' experience; the other partner is the Van Camp Company.

The heart of this beautiful and efficient vessel, of course, is its power plant, a Diesel big enough to give a speed of better than 11 knots in smooth water. This engine is an Enterprise, 8 cylinders 16" bore by 20" stroke, delivering 1050 hp. at 325 rpm. This is not a supercharged model.

Cooling is closed circuit, using a Thermo-Exchanger, made by the Cooley Mfg. Co., San Francisco. A Kingsbury thrust is built-in. The automatic alarm system is by the Detroit Lubricator Co., sounding a horn for low lube oil pressure or excessive cooling water temperature. The pyrometer system is Alnor, with a thermocouple for each cylinder and another one for the exhaust line. The gauge board bears the Weston tachometer dial, with gauges for lube pressure, fuel oil pressure, starting air pressure, circulating water pressure, sea water pressure, and the Alnor selective indicator.

Lube oil is filtered by a Cuno filter—included in the Enterprise equipment—and also by a Winslow Engineering Co. industrial-type filter. The fuel system has a built-in Purolator and also an Engine Life filter in the line from the inner bottom up to the day tank.

A Manzel lubricator is installed, for the cylinders only, for sure lubrication at low speeds; another Manzel is installed aft for lubricating all intermediate shaft bearings. Starting air is provided by 2 Westinghouse Air Brake Co. compressors, driven by 7.5 hp motors.

Fuel injection is Bendix, with individual pumps for all cylinders. Pistons are oil-cooled; in purse seining operations, there is much low speed operation, a condition under which many engines often overheat; which explains the oil-cooled pistons for this job and also the Manzel for the cylinders.

The lube oil transfer pump is a rotary, Woodin & Little, driven by a 15 hp motor; fuel transfer is by a Roper gear pump with a 3 hp motor.

Auxiliary power is also full Diesel. On each side of the main engine is installed an Atlas Imperial Diesel, 6 cylinders, 9" bore by 10½" stroke, rated at 230 hp at 600 rpm. Each engine is direct connected to a Columbia Electric generator, 150 kw, a.c., 220 volt, 60 cycle, 3 phase, each generator being equipped with a 125 volt exciter.

The Enterprise propulsion Diesel was furnished by the New Orleans branch of the Enterprise Engine & Foundry Co., Paul Wabnig, district manager. The Atlas auxiliary units were furnished by Arthur Duvic's Sons, New Orleans, with installation and starting supervision by sales engineer Lew Jensen. Woodward governors and Alnor pyrometers feature both Atlas installations.

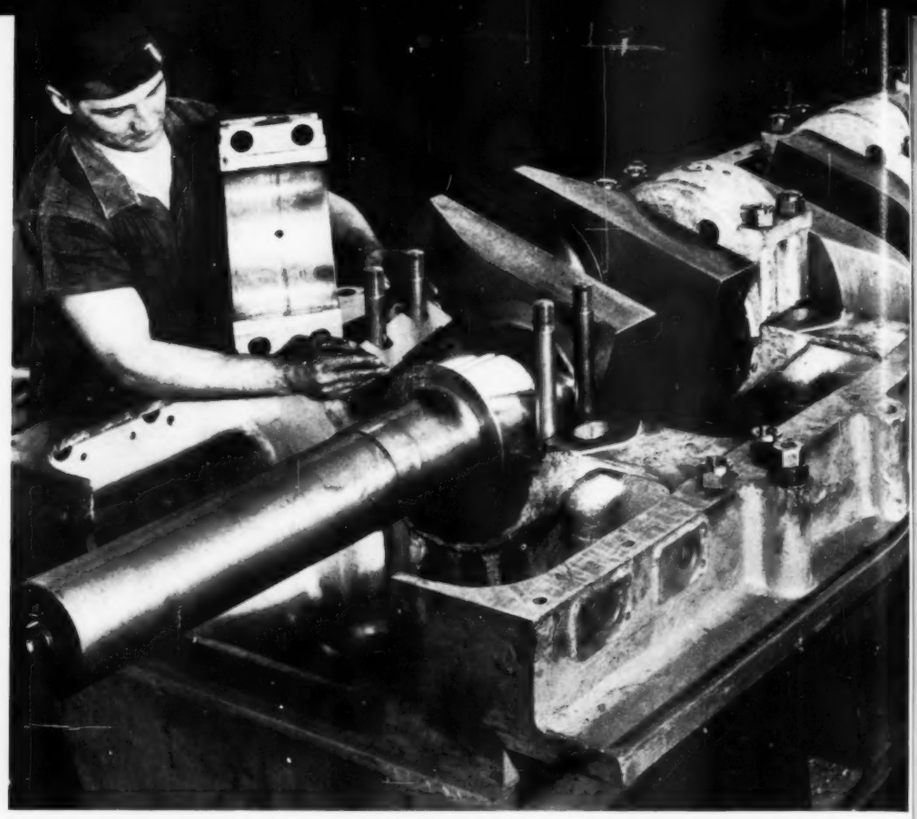
Avondale Marine Ways, Inc., built this fine vessel at their Mississippi River shipyard at Westwego, a few miles upstream from New Orleans on the other side of the river. This is the fifth all-steel tuna vessel built by this well-known yard for the Pacific tuna fisheries, and the finish and workmanship throughout is smooth and high-class.

Tuna boats, incidentally, are equipped to freeze their catches at sea and stay out until their storage capacity is filled. *Santa Helena* has a 10,000 mileage cruising range and her refrigeration system is carefully engineered.

The boat has five wells on each side, lined with ammonia coils. These tanks are filled with sea water and the temperature is reduced to around 32 degrees; salt is added and the temperature then further reduced to around 25 degrees, cold enough to freeze the fish but still warm enough for brine to circulate. Fish are brailed directly into the hatches of the tanks, into the freezing brine. This 25 degree temperature is held until the fish are completely frozen, which may take up to two days, according to the size of the fish. After freezing is completed, the brine is pumped out and if sufficiently clean, is put into another tank; if not, it is thrown away. The tank, free from brine and dried out, full of frozen fish, is then brought down to a zero temperature and held there until the boat reaches its home port. Procedure is to use one tank at a time, filling it with brine and fish, drying it out and then reducing the temperature; when the tanks are all full, it's time to go home.

Other important equipment includes Burgess snubbers, spark arrestor type, for the propulsion and both auxiliary Diesels; Goodrich Cutless stern bearing; American Blower Corporation ventilation fans; Submarine Signal Fathometer; Sperry Gyroscope, Mark XIV unit with 3 repeaters; Liquidometer rudder angle indicator and Sperry follow-up pointer on triple steerer unit.

# Manufacture Of Precision Shims



Installing laminated shim between halves of connecting rod bearing of Rathbun-Jones Diesel engine.

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Machinist locates 1/8-inch Laminum shim for main bearing installation of Superior Diesel engine.

MANY industries play an important part in the manufacture of a Diesel engine and not the least important of these industries is that of the manufacture of shims. In the Diesel industry, the use of shims is widespread and despite the introduction of precision bearings shims are still used on the main and connecting rod bearings of the larger Diesel engines manufactured today. The use of shims for bearing adjustments represents only a fraction of the applications to which they are put. Among these are their use for crosshead adjustment, gear or pinion meshing, preloading or adjustment of anti-friction bearings, and aligning or spacing of all kinds of parts. In some cases the use of solid steel shims has permitted the utilization of precision type bearing shells in main and connecting rod bearings designed for extended shims.

The Laminated Shim Company of Glenbrook, Conn., has been in the business for thirty-five years and during that time has established itself ar a leader in the field. The outstanding development of the company during this period has been the introduction of the laminated shim. This improvement in the making of shims has simplified many manufacturer's and machinist's job.

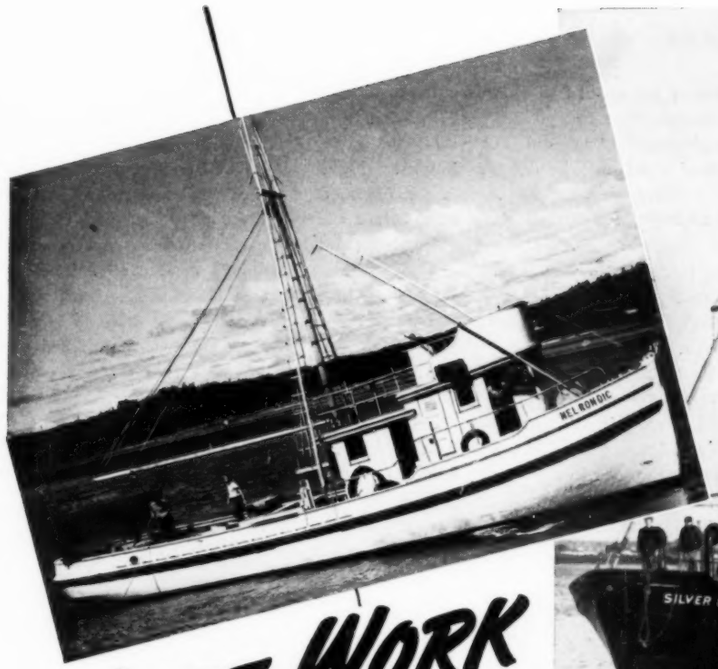
The Laminum shim, as this particular product is called, is composed of brass or steel laminations alternating with layers of metallic binder. These metal layers or laminations are made as thin as .002 inch. The bonding process gives to the unit structure a compression resistance equal to or better than that afforded by an equivalent thickness of solid brass stock. When installing these shims, it is only necessary to peel off the laminations to fit the application. For pressure lubricated bearings a babbitted type shim has been developed which is a regular laminum shim with soft babbitt metal lugs which act as an oil seal at the bearing ends.

The manufacture of these precision shims is painstaking to say the least. Each order is handled individually and promptly in a modern well-equipped plant in Glenbrook, Connecticut. Cold rolled brass and steel used in the manufacture of Laminum shims is carefully checked for plus and minus tolerances and the patented laminating process is carefully controlled to keep tolerances within very close ranges. When it is considered that 95 per cent of production is in the fabrication of shims to customer's blueprint specifications and that the number of customers is in the thousands, it is easily seen that each order must be carefully handled. Special dies are required for many of the thousands of shims cut at the plant. On small orders however the cutting is done by hand or by simple dies. If orders for this particular part become numerous, a special die is made to reduce the overall cost of manufacture.

For ordinary maintenance and repair work Laminum is manufactured in strips of varying dimensions to be cut on the job.

Practically all the leading Diesel manufacturers have used or are using these shims. Outgoing orders remind one of this fact.

Built-up shims are used extensively today. These comprise solid steel shim stock with an additional layer of Laminum stock, for shim adjustment. Another development has been the use of shims to adjust and position ball and roller bearings. Aside from assuring accurate adjustment and alignment of shafts, laminated shims can save 10 to 20 per cent assembly time. This has been particularly true in the machine tool industry, but is equally valid in any precision anti-friction bearing work.




The 55-foot tuna fisher, "Nel-Ron-Dic," Coos Bay, Oregon, is equipped with Twin Disc Front Power Take-off and Twin Disc MG-165 Marine Reverse Gear.

The "Silver Bay," Portland, Maine, operates its forward winch through a Twin Disc Power Take-off.

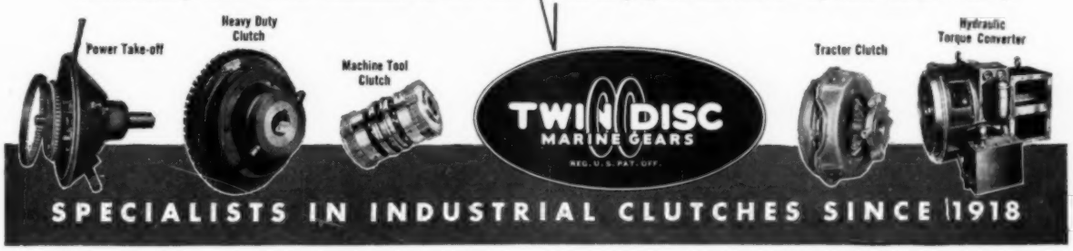

# MORE WORK
## from Your Engine

A Twin Disc Power Take-off.

Thousands of Twin Disc Front Power Take-offs are transmitting power efficiently from main engines to such auxiliary equipment as drag, brail and anchor winches, halibut gurdies, fire and bilge pumps, air compressors and generating sets. Unit design . . . consisting of a complete clutch power take-off assembly with shaft and bearings mounted in a rigid cast iron housing . . . provides for easy assembly to your engine.

Particularly suited for installation on the front of marine engines, Twin Disc Power Take-offs are available where standard SAE flywheel dimensions are employed. Clutches in these Power Take-offs range in size from 6.5″ to 14″ single plate and from 11.5″ to 14″ double plate. Housing sizes are from SAE No. 1 to SAE No. 6. Capacities range up to 140 hp.

For complete information on Twin Disc Power Take-offs, write for Bulletin No. 129-B. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford Illinois).




SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

# Exchange Your Diesel Maintenance Ideas

*Conducted* by R. L. GREGORY

*Editor's Note: In this department we provide a meeting place where Diesel and Gas engine operators may exchange mutually helpful maintenance experiences to keep our engines in top condition. Mr. Gregory edits your material and adds constructive suggestions from his own wide experience. This is your department—mail your contributions direct to DIESEL PROGRESS.*

## The Use of Additives As An Aid in Cutting Maintenance Costs

THE use of additives in fuel oil for large diesel operation is a practice which has been adopted in comparatively recent years. Back in the early nineteen twenties, an abundance of fuel oils of all grades and qualities was on the market. It was a "buyers market" wherein one could pick his product. All grades of gasolines, light and heavy fuels were obtainable in any quantity at very low cost. Since this condition existed, fuels with a minimum of sludge and foreign matter were common. After the first world war there was a great deal of activity in the automotive industry and some difficulties were encountered with sludge formations in the crankcase and as many grades of low test gasoline were on the market, considerable carboning of valves and heads were experienced.

About this time a few types of additives were developed, which additives were either added to the gasoline supply or placed in the crankcase oil. The manufacture of these additives and the use thereof was met with ridicule, condemnation and derision by both fuel and lubricant vendors alike. The idea of an outsider trying to improve these conditions by putting additives in the fuel and lubricants was preposterous. But some of the automotive personnel went ahead and tried them out, with the result that additives to fuel and lubricants became acceptable in many quarters.

The war created a greater demand for both fuel and lubricants, and we who operated diesel units during the war are thoroughly familiar with the difficulties encountered in procuring the good fuels and lubricants we were accustomed to prior to the war era. The lubricant problem was not so serious and lubricating engineers had long recognized the advantage of additives in lubricating oils. As a result of this abnormal demand for fuel oils, the quality did deteriorate and more sludge and carbon formations were encountered. This brought up the situation experienced in earlier years by the automotive industry. Something had to be done to eliminate this sludge and carbon and left an opening, wherein the additive manufacturer could step into the picture.

The marine industry always on the alert to improve conditions in operating and maintenance practice adopted additives for their fuel. The results were more than gratifying. We are all very familiar with fuel conditions as they exist today. There is no such thing as a "buyers market" in fact the plant or industry which is lucky enough to have a surplus of fuel oil on hand is to be congratulated. This lack of adequate fuel has been brought about by not one, but several conditions, some of which may be noted as follows:

(A) There are 3,000,000 more automobiles on the highways today than there were before the war. This includes new automotive equipment and many holdover "junkers" which are still operating, due to the inability to get new equipment. These "junkers" are using more gas and lubricants daily, as their efficiency drops.

(B) Nearly every industry that could possibly do so has converted from coal to oil fired boilers.

(C) Hundreds of thousands of homes have installed oil burners for domestic heating and are still doing so, despite the ever growing shortage of light fuel oils.

(D) The aviation industry is expanding all the time requiring more fuel and lubricants.

(E) Railroads are converting their motive power from steam to diesels.

(F) And last but not least, the heavy diesel units are daily being placed in service as prime power in industry and power plants.

As a result the demands for gasoline and light fuel oils has been vastly increased, and with crude oil supplies cut to the refineries, they in turn have gone to the catalytic system of manufacturing these products. This system allows them to get considerably more of the lighter fuels and gasoline from their crude and brings the heavy fuels available for heavy diesel operation down to a minimum.

We, who have the operation of these larger types of diesels under our supervision, as well as the manufacturers of these units, are desirous of procuring the best possible efficiency in daily operation. We further know that inferior fuels or lubricants are not conducive to high efficiency since such fuels are full of sludge and carbon forming ingredients. Sludge and carbon cause trouble, clog the fuel lines, meters, tanks, atomizing and injection equipment. Poor lubricants cause varnish formations, sticky rings, etc., in conjunction with the fuel.

Now what will these additives do to correct this situation. This can best be explained by taking a concrete example of what we experienced in our plant. Last fall we noted that there was a considerable amount of sludge forming in our day and service tanks. Fuel lines which are two inches in size, and accompanying fittings were becoming coated with sludge deposits which were heavier where fittings and valves were installed.

We removed these lines, cleaned them and steamed them out and replaced same but within a couple of weeks they were again accumulating sludge. Fuel injection equipment, filters, and strainers needed more frequent inspection and cleaning. As a result we decided to try an experiment, since we had heard arguments both pro and con as to the use of additives in fuel oil. We procured about a pint of heavy sludge from the bottom of one of our strainers, placed it in a pint bottle and added two tablespoonfuls of a well known fuel oil additive. This mixture we shook up well and let it stand for about thirty minutes, then inspected it. To our surprise we found it thoroughly fluid and free flowing and with the exception of a few very small particles was thoroughly combustible. These particles were later found to be grit which no additive would have dissolved.

We were now prepared to experiment further. We have four day tanks of 550 gallons capacity each located on an upper gallery. These tanks are so interconnected that they may be filled from the outside storage tanks by means of two transfer pumps and any tank can be used on any unit. We emptied these tanks one at a time, left the sludge in them and then refilled them one at a time with oil from the storage tanks. As each tank was filled we supplied a gallon of additive to the oil by feeding it in on the suction side of the pump. This mixed the additive with the fuel oil, which fuel passed through a fuel filter between the pump and the tanks.

Seven days later we repeated the process and operated for another week. At the end of the week we inspected the tanks, fuel lines, meter and injection equipment and found that practically all trace of sludge had disappeared, our fuel lines were free from side wall deposits and injection equipment in good condition. The following week end we removed two pistons to inspect the rings and found them in good shape, none sticking, and a minimum of carbon deposit. Along with this we found an increase in the kwh. produced per gallon over previous weeks.

We concluded that we had something and since that time have religiously added a gallon to each tank a week to hold the sludge deposits down once we had the tanks and lines cleaned. Of course the amount of additive used depends on the amount of fuel used and some weeks we use more than others.

As a result of these trials we are convinced that fuel oil additives are not only practical but essential. These additives are made by several reputable companies and while they range in price from $2.50 to $5.00 per gallon depending on the quantities purchased and the vendor supplying same, the small amount spent to improve fuel oil conditions more then warrant the expenditure.

The saving on maintenance time, cleaning equipment, inspecting parts and general overhauling of parts effected is most noticeable, hence comes to you as a maintenance suggestion.

### Correction

In the March issue of DIESEL PROGRESS, under the Maintenance Section, page 66, an idea was suggested by Supt. Monson of the Fosston Minnesota, Municipal plant as regards the removal

. . . . . *And now please turn to page 48* . . . .

## Exchange Ideas Section

. . . . . *Continued from page 46* . . . . .

of oil from a barrel with air pressure. This method was criticized by H. J. Clarke of the Chicago Bridge and Iron Company in the April issue and most deservedly so, since Mr. Monson made no provision for safety in his suggestion.

Many plants use this method but have either a reducing valve in the air supply line to limit the amount of pressure that can be applied to the barrel, or in its place use a low relief valve on the barrel to relieve any excess pressure. Many serious accidents have occurred from failure to properly protect this method of oil removal from excess air pressure.

We not only use air for the removal of oil from barrels, but also in pushing clean filtered oil from our Youngstown-Miller batch filter in the basement to the clean lub oil tank on the second gallery of our plant. However in both situations, the equipment is properly protected against excessive pressure by both reducing and relief valves, this being a double protection. This method should never be used without adequate protection as to excessive air pressure.

## D.E.M.A. Meets With Educators At Texas Company Beacon Laboratories

MORE than forty engineers representing the engineering faculties of leading eastern colleges and universities recently attended a diesel engineering meeting jointly sponsored by the Texas Company and the D.E.M.A. at the Texas Company Laboratories at Beacon, New York. A highly interesting and informative program was presented whic included a series of talks by Texas Company eng neers and personally conducted tours of the r search laboratories.

The Beacon Laboratories, established in 193 with a staff of 125 persons has grown to such a extent that now the staff includes more than 75 Plans for further expansion are well under wa

A considerable portion of the work is devote to research on products for diesel engines. Th Fuels Research Department and Products Appli cation Department for diesel test work have a wealth of diesel equipment with which to car on its research program.

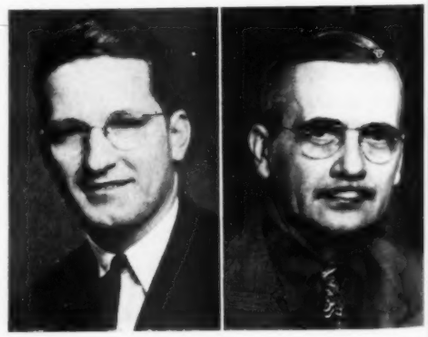
The results of some of this test work was de scribed to the guest engineers by Texas researc men. Harry Levin, Supervisor of the Analytica and Testing Department, led off the discussion with a paper on "Significance of Analytical Tes as Applied to Diesel Engine Operation." This wa followed by a talk by P. A. Binda on "Full Scal Testing of Petroleum Products." The afternoon session was devoted to two papers by R. R. We miller, "Diesel Smoke and Odor" and "Diesel Engine Wear." Highlight of the day was a talk by E. M. Barber, Supervisor of Engineering Re search Dept. on "Texaco Combustion Process."

These talks were interspersed with inspection trips to the various laboratories where the equip ment discussed was shown to the guests.

In subsequent months DIESEL PROGRESS will present in detail some of the developments in diesel engineering being carried on at the Texa Company's Beacon Laboratories.



## Young Radiator Adds To Staff



P. C. Mortenson J. A. McBride

Two additions to the staff of the Mechanical Engineering Department of the Young Radiator Company were announced recently by F. M. Young, President of the company.

Paul Mortenson, born and raised in Racine, has been assigned to the Contract Products Division as a Sales Engineer. During the war years Mortenson worked in the Engineering Department at Lockheed where he contributed in the development of the Navy's PV 1 and Lockheed's P-80 Shooting Star, the first combat jet-propelled aircraft.

James A. McBride, Industrial Engineer, comes to the Young organization from the Cord Corporation where he was Coordinator of Engineering and Production, in which capacity he acted as Special Assistant to E. L. Cord.

## Rex W. Wadman To Address S.A.E. Summer Meeting

DIESEL ENGINE ACTIVITY WILL SPONSOR TWO SESSIONS DURING THE SAE SUMMER MEETING AT FRENCH LICK, INDIANA, JUNE 6-11.

THE entire evening session, Wednesday, June 9, will be given to a talk on Fifty Years of Diesel Engine Development in the United States, by Rex W. Wadman, Editor and Publisher of DIESEL PROGRESS, with Harry Bryan of International Harvester Company and S. A. E. Vice President for Diesel Engine Activity acting as chairman of the session.

The other Diesel session, scheduled for Thursday afternoon, June 10, will hear a paper on the Production and Performance of Diesel Fuels by J. R. MacGregor, G. R. MacPherson and P. L. Pinotti of California Research Corporation, to be followed by J. W. Barriger, President of the Monon Railroad, whose subject is Super-Power for Super-Railroads. Wilbur W. Young, Managing Editor of DIESEL PROGRESS, will be chairman of this session.



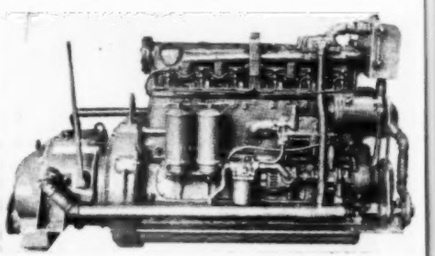
### Rodman Named Wolverine Vice President

P. W. Rodman

AT the annual meeting of the stockholders and directors of the Wolverine Motor Works, Inc., recently, Perry W. Rodman was appointed Executive Vice President as well as Treasurer of the Corporation. He will be the active head of the corporation's manufacturing operations as well as being in charge of sales.

Rodman has been connected with the Wolverine Motor Works for the past two years during which time the corporation has regained its position in the marine field on the Atlantic Coast. The company is, as in the past, doing a large volume of business abroad in both marine and stationary engines.

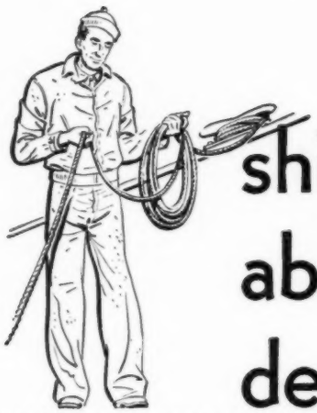
### New Marine Diesel Announced



Meco marine diesel with electric starting equipment and heat exchange cooling equipment, starboard side.

THE Mechanical Equipment Company of New Orleans, La., has recently announced a line of Marine Diesel Engines ranging from 40 to 300 hp. They will be built in 6 different cylinder sizes ranging from 3¾- to 8½-inch bore. The engines are called Meco Marine Diesel engines and are of the four cycle, solid injection, full Diesel type. They are constructed for both right and left hand propeller rotation and equipped with either electric or gasoline engine starting. They are equipped with reverse and reduction gears with optional reductions ranging from 1:1 up to 3:1. They can be equipped with front end power clutches when required. They are designed for either heat exchanger or keel cooling. The Meco Diesel is particularly suited for tug, workboat, trawler and yacht installations.

For further information write for bulletin A10-11-47 from Mechanical Equipment Company, 861 Carondelet Street, New Orleans 13, La.



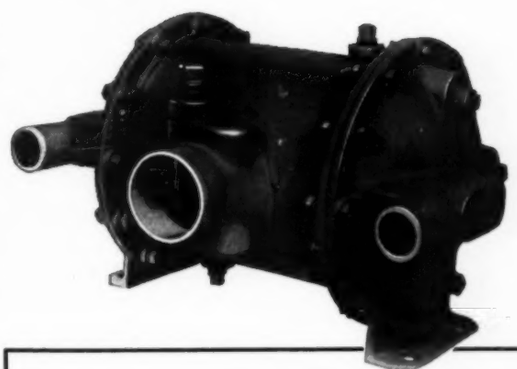
# shipshape above decks

# shipshape below

Harrison Heat Exchangers help keep ships' engines in good working order. By maintaining lube oil and jacket water temperature within proper limits, they prevent excessive wear and insure better performance.

Each Harrison model is engineered to provide maximum efficiency and dependability in its particular application. A complete range of sizes is available to meet the requirements of Diesel and gasoline engines, large and small.

If you have a marine cooling problem, consult Harrison. You will find a broad background of engineering experience at your service.



*HARRISON*

**OIL COOLERS**

**JACKET WATER COOLERS**

**HARRISON RADIATOR DIVISION OF GENERAL MOTORS, LOCKPORT, NEW YORK**

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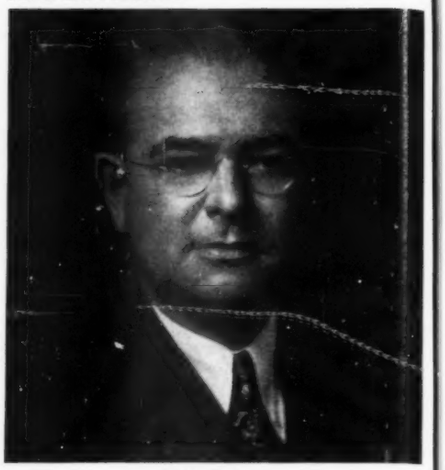

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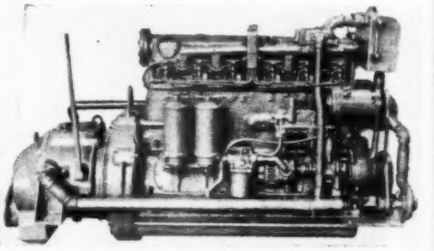

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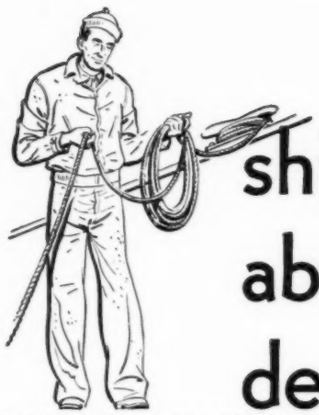

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Each Harrison model is engineered to provide maximum efficiency and dependability in its particular application. A complete range of sizes is available to meet the requirements of Diesel and gasoline engines, large and small.

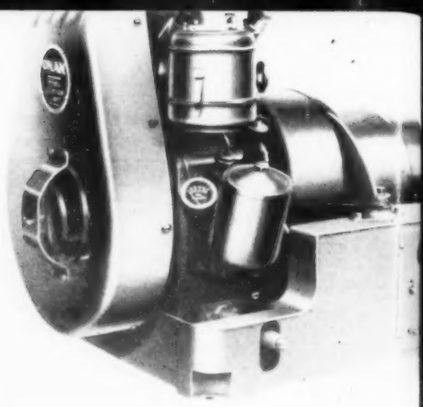
If you have a marine cooling problem, consult Harrison. You will find a broad background of engineering experience at your service.

HARRISON

OIL COOLERS
JACKET WATER COOLERS

HARRISON RADIATOR DIVISION OF GENERAL MOTORS, LOCKPORT, NEW YORK

Air cooled diesel drives this Onan 2500 watt generator.



# New Diesel Generator Sets

Onan enclosed diesel electric plant is powered by Buda diesel.

TWO new lines of diesel electric plants, air-cooled and water-cooled, completely equipped and self-contained, have been developed by D. W. Onan and Sons, Inc.

The new Onan DSP air-cooled diesel engine is the prime-mover for the Onan Model 205DSP, 2500 watt diesel electric plant. Powered by this compact, one-cylinder, four-cycle engine, this new diesel unit makes the economy of full diesel operation available to all users who must supply their own electric power. Its unusual compactness, (10½ cu. ft.) assures maximum adaptability to a wide range of portable or stationary jobs. The application of air-cooling to this diesel engine simplifies servicing and reduces maintenance costs.

The Model 205DSP is economical to operate; approximately 0.136 gallon of fuel is required per kilowatt hour at full rated load.

Electric cranking of the engine is made possible by a specially designed automatic compression release. Conservatively rated at 2500 watts, the plant has an Onan inherently regulated generator which provides good voltage regulation without the use of rheostats or other external equipment. All engine and generator controls required for operation are conveniently located on the steel base. Rubber shock-mounting eliminates the need of an extra-heavy mounting base.

Onan air-cooled DSP diesel electric plants are available in alternating-current models of 2500 watt capacities, 60 cycle, and voltages of 115 or 230, single-phase, or 115/230 volt, single-phase, three-wire, or 230 volt, three-phase, three-wire.

Standard accessories include two heavy-duty, 6 volt starting batteries connected in series, oil filter, oil bath air-cleaner, muffler, two flexible fuel lines, hand crank and one extra fuel injection pump, holder and nozzle. Battery cables, battery hydrometer and remote start-stop station are also included.

Onan water-cooled diesel electric plant, in 10,000 to 35,000 watt capacities, are powered by heavy-duty Buda diesel engines. They are enclosed in weather-proof, sheet-steel housings with removable side-panels for easy servicing. The welded base is made of heavy structural steel.

A welded steel battery-and-accessory rack contains two six-volt starting batteries. Models of 35 kw. are equipped with extra-heavy-duty batteries. A 12 volt, belt-driven generator keeps all batteries fully charged.

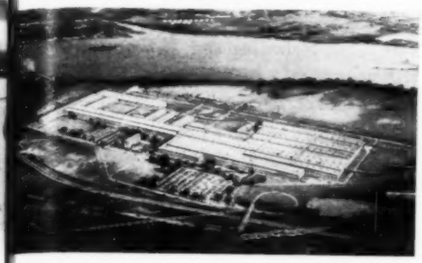
Onan water-cooled models also have the inherently regulated generator which provides close regulation without the need of separate regulators. Other features include circuit-breaker, low oil pressure cut-off and over temperature cut-off switch.

The engine instrument panel, as well as the electric instrument panel, is built-in, thus eliminating the need for a separate switchboard. The panels are illuminated by a 12 volt pilot light. All alternating-current models have a running time meter.

Onan water-cooled models are available in capacities ranging from 10,000 to 35,000 watts, alternating current, in 60 cycle, single and three-phases, all standard voltages; also available in 50 cycle.

D.C. Models of 10 kw. and 15 kw. are available in either 115 or 230 volt.

## New Alcoa Rolling Mill



THE greatest single application of aluminum ever achieved in the building trades was unveiled at Davenport, Iowa, with the disclosure by Thomas D. Jolly, vice-president in charge of engineering and purchases, Aluminum Company of America, that the company is using more than six and a quarter million pounds of aluminum in the construction of its nearly-completed Davenport sheet and plate rolling mill.

The giant plant, extending for nearly a mile along the banks of the Mississippi river, is basically an all-aluminum project, with the exception of 25,000 tons of structural steel framework which is painted with more than three carloads of aluminum paint.

More than three miles of aluminum insulated wall panels, weighing over a million pounds, compose the bulk of the exterior surface of the huge project. The remainder consists of nearly 500,000 square feet of aluminum window sash, and part of the plant's 400-odd aluminum doors. Covering the modern rolling mill, which has grown on what was a 400-acre farm site two years ago, is an aluminum roof which sprawls over 47 acres and contains nearly 3,000,000 pounds of the metal.

## A New Improved Expander Spring

SEALED Power Corporation recently announced an improved expander spring for the Sealed Power MD-50 Steel Oil Ring. Among the advantages claimed for this new Sealed Power spring are increased direct ventilation for greater oil economy, more independent action for steel segments, free and unobstructed circulation of oil through all slots in cast iron spacer and oil holes or vents in the piston. The design of the new spring compensates for greater variation in groove depth without loss of tension and assures greater bearing area at points of contact with both piston and ring, resulting in longer spring life.

A SURVEY of Twin Disc marine equipment in West Coast boats is featured in the latest issue of Production Road, a magazine published by the Twin Disc Clutch Company, Racine, Wis. Copies of the Marine Issue of Production Road may be obtained by writing to the Twin Disc Clutch Company, Racine, Wis.

TWO FORMER NAVY L.S.T.'s are now undergoing conversion at Avondale Marine Ways, Inc. They are owned by The Humble Oil & Refining Company, and are to be used as mobile power units in drilling the marine oil fields off the South Louisiana coast in the Gulf of Mexico. These ships will be completely equipped with all auxiliary machinery required for drilling purposes. Quarters for 59 will be provided including dining salons and sleeping accommodations. The modern galley and refrigeration plant will be adequate for sustaining the crew for a period of at least two months.

THE ERIE RAILROAD has initiated the most comprehensive main line installation of very-high-frequency radio-telephone equipment yet undertaken by any railroad, it was announced recently by R. E. Woodruff, Erie President. The railroad already has begun installation of the radio system on its Kent, Mahoning and Meadville Divisions Mr. Woodruff said, to provide complete coverage over more than 300 miles of main-line trackage between Marion, Ohio, and Salamanca, New York. Complete installation with full operation is expected by May first. Equipment used in the system is being delivered by the Farnsworth Television & Radio Corporation.

All main-line Diesel passenger and Diesel freight locomotives operating over these three divisions of the Erie will be radio-equipped, Mr. Woodruff said. In equipping both cabs of seven three-unit passenger locomotives and nine four-unit freight locomotives as well as 15 cabooses, a total of 47 mobile radio installations will be made. In addition, 14 wayside offices will be equipped to provide complete radio coverage.

TEXACO DEVELOPMENT CORPORATION is now prepared to license anyone within the petroleum industry to manufacture synthetic fuels by means of the Hydrocol Process, W. M. Stratford, President, announced recently at a press conference. The new process, Mr. Stratford said, resulted from the joint and continuing research efforts of Hydrocarbon Research, Incorporated and The Texas Company. It is this process which will go into operation on a large commercial scale early in 1949 at the Hydrocol plant at Brownsville, Texas and at the Stanolind plant at Hugoton, Kansas. Each of these plants, when completed will produce more than 300,000 gallons per day of synthetic gasoline.

R-S PRODUCTS CORPORATION has just published a completely detailed catalog and price sheet on their new Leveltronic Relay, designed for basic applications in the control of liquid level, interface, pressure, and temperature. Catalog is listed as No. 27. It is available on request to R. S. Products Corporation, Electronic Division, Wayne Junction, Philadelphia 44, Pa.

ALLIED CONTROL COMPANY, Inc., manufacturers of relays and electrical devices in New York and Connecticut, had a plan for reorganization confirmed by the United States Federal Court in Chicago in recent months.

Mr. Von Egloffstein has been elected President, James McDill, Controller and J. K. Holbrook, Jr., Secretary.

Any further information regarding the plan for organization may be obtained by addressing an inquiry to the secretary. Executive offices of Allied Control Co., Inc., are located at 2 East End Avenue, New York 21, N. Y.

STREAMLINED EMPIRE BUILDER fleet, which completed a full year's operation on February 22, has turned in a 98 per cent on-time terminal

## News of the Industry (Cont.)

arrival performance, according to Thomas F. Dixon, Great Northern Railway operations vice president.

Dixon said the Diesel-powered five train fleet has traveled 1,300,487 miles between Chicago and Seattle-Portland during the year.

CUMMINS DEALERS throughout the United States are distributing the latest issue of "The Dependable Diesel," a publication for users of Diesel power engines, issued by the Cummins Engine Company, Inc. The current issue contains stories about Diesel trucking in the Southwestern United States, the use of Diesel trucks underground by the Eagle-Picher Mining and Smelting Company, an account of the repowering of five motor cars by the Baltimore and Ohio Railroad and other stories of Diesel applications. Copies of "The Dependable Diesel" may be obtained from any Cummins dealer or by writing to the Cummins Engine Company, Inc., Columbus, Ind.

LINK-BELT COMPANY announced recently that, in order to better serve customers in the State of Delaware, they have established a district sales office in Wilmington, with headquarters at 905 Orange St., Wilmington 43. Wililam H. Kinkead, associated with the company's Philadelphia plant in various capacities since 1920, has been appointed district sales manager in charge of the new office.

A NEW BOOKLET *Caterpillar Scrapers at Work* devoted exclusively to the problems of earthmoving has recently been published by the Caterpillar Tractor Co. Pictorially and editorially describing the loading, hauling and spreading jobs done by the "Caterpillar" No. 60, 70 and 80 scrapers packages with the "Caterpillar" Diesel D6, D7 and D8 track-type tractors, the publication should prove of interest to all contractors faced with earthmoving problems. Copies of *Caterpillar Scrapers at Work* may be secured from the Caterpillar Tractor Co., Peoria 8, Illinois, by requesting Form No. 10748.

PLOMB TOOL COMPANY announced recently that any ½-inch drive socket wrench handle or attachment can be converted into a ratcheting device with a new tool, known as the Ratchetor. The tool has a ½-inch square plug with ball-check for holding a socket wrench, a ½-inch square opening for insertion of a handle or attachment and a reversible ratcheting mechanism. For further information write the Plomb Tool Company, Los Angeles 54, Cal.

Plomb Ratchetor

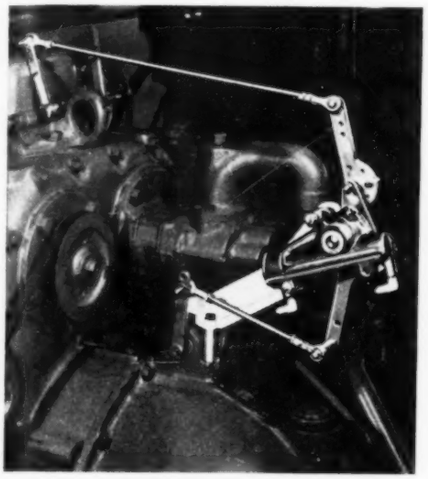
A NEW TOOL to measure speeds of rotation with extreme accuracy is now available for laboratory, test stand and general applications. The new Metron Precision Tachometer is accurate to ¼% of the speed being measured and is of the continuous indicating type, covering wide speed ranges. Two types are available, identical except for speed ranges: Type 48H, for speeds of 900 to 10,000 rpm.; and Type 48J, for speeds of 90 to 1000 rpm. Each has ten overlapping ranges, selected by a rotary switch. No damage is incurred by accidental selection of the wrong range. Write Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado, for further information.

Metron Precision Tachometer

THE BALL ASSOCIATES, Inc., 74 Niagara Street, Buffalo, New York have recently been appointed exclusive representatives for Burlington Instrument Co. in the State of New York with exception

of Long Island, Metropolitan area of New York City, and the two southeastern counties of Rockland and West Chester. The company also announced the appointment of the Electric Sales & Engineering Company, 2209 South First Street, Milwaukee, Wisconsin, to represent the company in the State of Wisconsin.

ADEL PRECISION PRODUCTS CORP. recently announced the manufacture of a new hydraulic control system for remote operation of both clutch and throttle with a single control lever. The Combotrol is easily installed on General Motors Diesels.

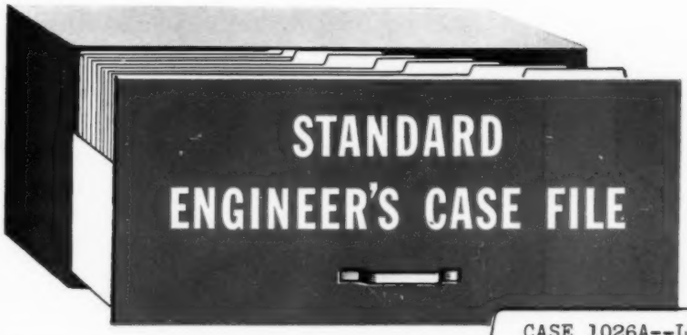


Adel Combotrol on GM Diesel

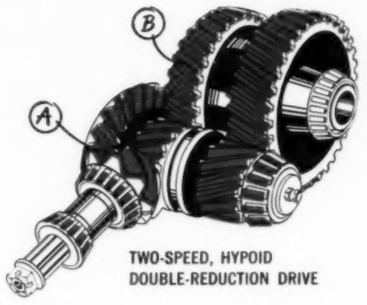
The Isodraulic Combotrol system consists of three units: master control, located on bridge; Slave Assembly, mounted on engine; and the Compensator, installed on the hydraulic lines interconnecting which compensates for any variation due to changes in temperature. For further information write Adel Precision Products Corp., Burbank, California.

INTRODUCTION OF A NEW SYSTEM to stimulate suggestions from its 41,000 employees has been announced by the Socony-Vacuum Oil Company, Inc. It removes ceilings on amounts which can be awarded to individuals for their ideas and establishes a uniform formula to assist in evaluating the suggestions.

LAUNCHED RECENTLY into the Ohio River by Dravo Corporation of Pittsburgh, the Diesel towboat, *Victory,* now is being outfitted and soon will join Dravo Keystone Division's fleet to tow sand, gravel and coal barges. Several improvements in design of the steel-hulled vessel enable her to develop 25,000 pounds "push" at 5 miles per hour. The 116-foot craft replaces a towboat of the same name purchased last year from Dravo Corporation by the Argentine Government to introduce "push-towing" on South American inland waterways. The new *Victory* is powered by two General Motors Diesel engines driving twin-screw propellers in Kort nozzles.




## CASE 1026A--LUBRICATING HYPOID GEARS IN HEAVY-DUTY SERVICE.




TWO-SPEED, HYPOID
DOUBLE-REDUCTION DRIVE

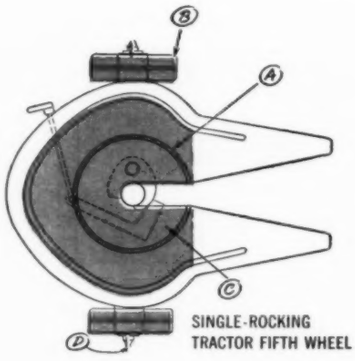
RPM Multi-Service Gear Lubricant reduced wear and fully protected multiple hypoid gear units in large trucks and buses operating in the most severe load and temperature conditions. For all types of hypoid gear units. Comes in four grades: SAE 80, 90, 140 and grade 75 for Alaska and other sub-zero weather localities.

A. Contains a special compound which reacts chemically - provides lubricant film that withstands extreme pressures and rubbing action of hypoid gears.

B. Highly oxidation-resistant, and rapidly carries away heat and cools gears.

Other compounds in RPM Multi-Service Gear Lubricant resist foaming and corrosion. The blend is stable, compounds will not drop out of solution. Conforms to U. S. Army specification 2-105-B. Timken Detroit Axle Co. recommends U. S. A. 2-105-B gear lubricants for their single and double reduction hypoid gears following the break-in period with factory lubricant.

## CASE 1028--MAINTAINING LUBRICATING FILM ON CHASSIS BEARINGS UNDER EXTREME PRESSURES.




SINGLE-ROCKING
TRACTOR FIFTH WHEEL

In the severest truck and bus service RPM Chassis Grease TB stayed on bearings longer than usual period between grease jobs. Improved product made specially for heavy-duty service. Has distinctive gray color. Comes in three grades: Light, Medium, Heavy.

A. Contains metallic anti-wear ingredient - resists wear and prolongs bearing life.

B. Cushions bearings against shock loads ... improved stringiness additive keeps film on surfaces - provides high adhesion and cohesion properties.

C. Heavy oil stock assures tough lubricant film - minimizes galling on large bearing surfaces.

D. Has excellent pumpability in cold weather - Light grade pumps freely in temperatures down to minus 10°F.

RPM Chassis Grease TB is waterproofed, keeps protective collar at outside edge of shackle bearings.

For additional information and the name of your nearest Distributor, write

**STANDARD OIL COMPANY OF CALIFORNIA**
225 Bush Street, San Francisco 20, California

**The California Oil Company**
30 Rockefeller Plaza, New York 20, N. Y.

**The California Company**
17th and Stout Streets, Denver 1, Colo.

**Standard Oil Company of Texas**
El Paso, Texas

RPM CALOL

Trademarks Reg. U. S. Pat. Office

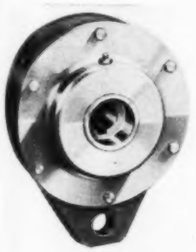
## Tubing Life Increased by Newly Developed Synthetic Hose

LONGER life tubing is the result of an extensive research program conducted by engineers of the Ronaflex Tubing Company, Inc. These improvements are the result of new Buna and Neoprene base synthetics which stand up under the punishment of high temperatures, pressures, vibration, internal and external corrosive solvents and fumes.

The Ronaflex assembly illustrated is carrying air at 80 psi. Tests indicate that this wire-braid Ronaflex has already served four times as long as those previously used and shows no sign of failure. One-quarter inch tubing will stand burst pressures to 100 psi. and larger sizes proportionally less. Installations for temperatures to 300°F. are not uncommon.

## Falk Backstop Prevents Reverse Rotation

THE new Falk Backstop provides a positive method for preventing reverse, rotation on conveyor drives, elevator head shafts, windlasses, winches, and on all applications where reverse rotation should not occur.



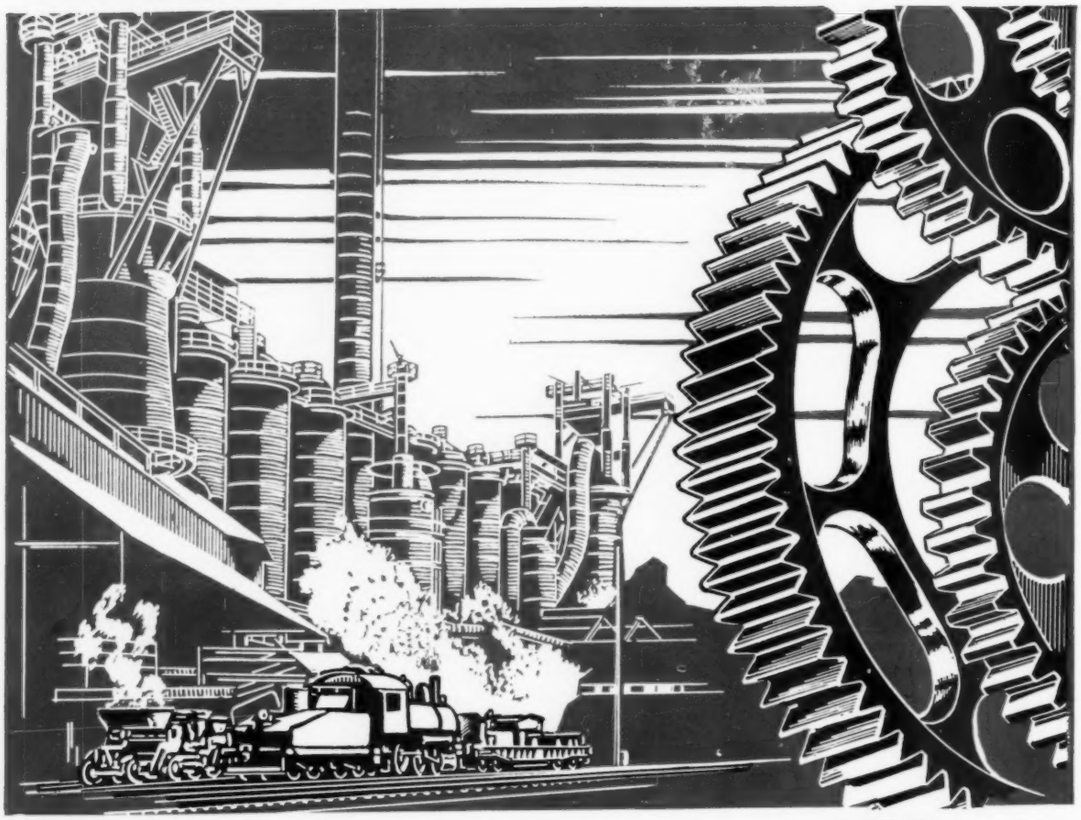
Falk Backstop

Falk Backstop Bulletin 10,080 provides complete information on sizes, capacities and dimensions. Copies of this bulletin are available upon request to The Falk Corporation, 3001 West Canal Street, Milwaukee 8, Wisconsin.

## Huleguard Resigns Whitcomb Locomotive Managership

H. V. HULEGUARD has resigned as Vice President and General Manager of the Whitcomb Locomotive Company, a subsidiary of the Baldwin Locomotive Works. He will continue his residence in Rochelle, Illinois.

# YES! Tycol "Engineered Lubrication" performs better . . . BETTER . . . BETTER



**Tycol Engineered Lubrication performs better because:**

. . . *Tycol Engineered Lubrication* is scientifically engineered to meet every service condition in modern industry, no matter how extreme or unusual.

. . . *Tycol Engineered Lubrication* helps you "get it done" faster and more efficiently . . . production jumps when you switch to a Tycol oil or grease.

. . . *Tycol Engineered Lubrication* means new economies for you . . . by cutting repair bills, and lengthening equipment life.

Let Tide Water Associated help you select the best lubricant for your particular need. Write, wire or phone today to your nearest Tide Water Associated Office.

TYCOL
INDUSTRIAL LUBRICANTS

**Boston • Charlotte, N. C.**
**Pittsburgh • Philadelphia**
**Chicago • Detroit • Tulsa**
**Cleveland • San Francisco**

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N.Y.

**LUBRICATION — "ENGINEERED TO FIT THE JOB"**

## Lubrication of the Low Speed Diesel

. . . . . *Continued from page 26* . . . . .

not as a vapor. Experimental evidence indicates that crankcase inflammation is propagated through an atmosphere of fine oil droplets, the mechanism being similar to the spontaneous combustion of coal dust. This sort of atmosphere is more difficult to ignite than a combustible mixture of petroleum vapors in air which seldom exists in a crankcase.

*Typical Engine Data*—Lubrication data on large two-cycle diesels are shown in table XVIII, where three each of three different makes of American engines are averaged and compared with two E[u]ropean diesels of approximately the same bore a[nd] stroke. The comparison shows the European e[n]gine operating at slower speeds, with fewer [p]rings, with larger oil sumps, at lower oil pressur[e] and at lower temperatures.

There is good agreement among the nine Ame[r]can engines on all counts, except in the amou[nt] of crankcase make-up oil. This figure varied co[n]siderably, even among engines of the same desig[n] using the same oil. It appears therefore that cran[k]case oil consumption is more dependent on engi[ne] condition than design.

TABLE XVIII

Lubrication Data, Averaged—Large Low Speed Diesels

| | | American Busch Hamilton Norberg | European B & W MAN |
|---|---|---|---|
| Engines | | | |
| Cylinder Size | | 21x28 | 20x31 |
| RPM | | 235 | 180 |
| Strokes per Cycle | | 2 | 2 |
| HP/cylinder | | 370 | 330 |
| Piston Type | | Trunk | Trunk |
| Bearing Metal Bands on Piston | | Yes | Yes |
| Compression Rings | | 6 | 6 |
| Oil Rings | | 3 | 2 |
| Cylinder Leads | | 6 | 6 |
| Oil Sump Capacity, gal/HP | | 0.4 | 1.3 |
| Oil Filter type | | Clay | Metal Screen |
| Crankpin Bearing | | Babbitt | Babbitt |
| Oil Consumption, HPHrs/gal, cyl | | 6300 | 6500 |
| brg | | 5800 | 6700 |
| Total | | 3000 | 3300 |
| Oil Pressure, bearings #/ sq. in. | | 25 | 15 |
| piston #/sq. in. | | 35 | 15 |
| Bearing Oil Temp°F | in | 120 | 96 |
| | out | 130 | 102 |
| Piston Cooling Oil Temp. °F | in | 120 | 96 |
| | out | 135 | 113 |
| Jacket Water Temp. °F | in | 122 | 95 |
| | out | 129 | 122 |
| Exhaust Temp. full load °F | | 480 | 470 |
| Piston Crown depth, in | | 3 | 4.5 |
| Cylinder Oil Viscosity SSU @ 210 °F | | 81 | 66 |
| Bearing Oil Viscosity SSU @ 130°F | | 232 | 244 |

CONCLUSION

As compared to a high speed diesel, a large low speed engine requires different lubrication treatment because the oil film is exposed to more heat and circulates more slowly over piston surfaces. To meet these conditions the designer provides oil-cooled pistons and improved methods of distributing oil over the cylinder surface, the operator keeps oil and jacket water temperatures at a comparatively low level and the oil supplier provides a lubricant refined to meet these and other requirements peculiar to the individual engine.

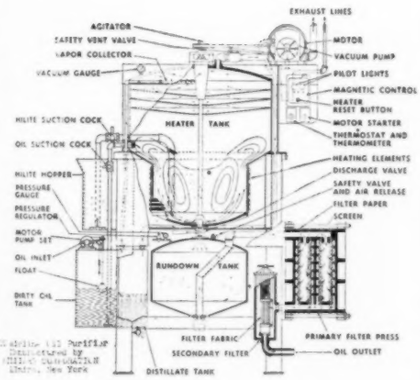
The illustrations accompanying this article include only those American diesels rated over 200 hp./cyl. and under 500 rpm.

## New Indicating Gauge Bulletin

A RECENT bulletin published by Manning, Maxwell & Moore describes and illustrates the complete line of Ashcroft gauges. Three distinct types of indicating gauges are presented—Duragauges, recommended for service where durability and high accuracy are essential: Quality cast case gauges, recommended for plant services on water, gas, oil, and steam lines: Drawn Case gauges, recommended for replacements on small equipment such as portable compressors, small pumps, and unimportant pressure lines.

A copy of this bulletin is available by writing Manning, Maxwell and Moore, Bridgeport 2, Conn.

## New Oil Purifer

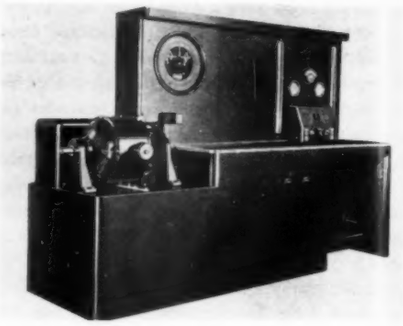



THE Hilliard Corporation has recently introduced its new Hilco Airline oil purifier, incorporating a number of new features, such as a secondary safety filter press and automatic filling device, which also acts as a heat exchanger and is attached directly to the distillate tank.

The new purifier as seen in the schematic cross section above utilizes Hilite (fullers earth) as an absorbent agent to clarify the dirty oil which is automatically metered into the equipment. Liquid contamination (water and fuel oil) is removed by distillation in the heater tank. After liquid contamination has been removed, the mass of oil and Hilite flows to a rundown tank. Compressed air is introduced into this tank, thus forcing the mass out through the primary filter press, where all the Hilite and solid matter are retained. The purified oil then passes through a secondary filter to storage.

Write to the Hilliard Corporation, 102 West 4th St., Elmira, New York, for further information.

## 25 hp Dynamometer



Emdco Model E Dynamometer

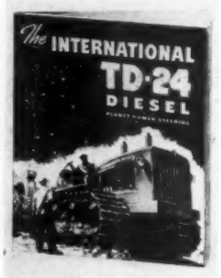
A NEW 25 hp. transmission and absorption dynamometer, with a speed range of 200 to 6500 rpm, was announced recently by the Electro Mechanical Devices Co. of Detroit. This new EMDCO Model E is designed for testing gasoline engines, electric motors, air compressors, fluid motors, fuel pumps and gear pumps.

The EMDCO Model E is a completely self-contained unit, with the motor generator set mounted and wired in the base. One control is used for all tests; no switching is necessary to go from motoring to absorption. The change is made automatically when the rheostat control increases or decreases in relation to the speed of the unit being tested. Torque is read clockwise on scale regardless of direction of rotation by dynamometer and is also read directly in foot pounds.

Complete specifications on the EMDCO Model E may be obtained by writing the Electro Mechanical Devices Co., 49 Selden, Detroit 1, Mich.

## Crawler Tractor Bulletin

A colorful, pictorial book on the new TD-24 crawler tractor is now available from International Harvester. This book uses the "picture story" techniques employed in modern magazine layout. Over 50 sectional views, line drawings and photographs – many in two colors – give a clear portrayal of the working functions of all important parts in the TD-24. Copies of the book may be obtained by writing to International Harvester Company, 180 North Michigan Avenue, Chicago 1, Illinois. Ask for Form No. A-34-LL.




## Lanno Joins Rockford Clutch

E. C. Lanno, formerly of the Detroit Diesel Engine Division of General Motors Corp., has been named Development Engineer of the Rockford Clutch Division of Borg-Warner Corp. The appointment was announced by Arch A. Warner, President of the Rockford Clutch Division.

for SERIES "71" General Motors and GRAY MARINE DIESELS • BRAND NEW, GENUINE SPARE PARTS at . . .

# PRICES THAT TALK

| PART NUMBER | | LIST | PRICE |
|---|---|---|---|
| **GROUP 1.000 ENGINE** | | | |
| | Complete Engine (Marine) ★ | 5500.00 | 3000.00 |
| 5158676 | Cyl. Block End Plate | 16.25 | 7.35 |
| 5152879 | Cylinder Block End Plate Gasket | 1.00 | .45 |
| 5158620 | Cyl. Bl. Hand Hole Cover Gasket | .10 | .05 |
| 5158624 | Cyl. Block Water Hole Cover Gasket | .05 | .02½ |
| 5152967 | Cyl. Head Assly. -2 Cyl. | 110.00 | 55.00 |
| 5158613 | Cyl. Head Stud Nut | .15 | .07 |
| 5158650 | Cyl. Head Engine Lifter Front Brkt. | 3.75 | 1.50 |
| 5158660 | C/S Dowel Pin | .15 | .07 |
| 5158617 | C/S Main Bearing Lower Std★ | 2.25 | 1.15 |
| 5152918 | C/S Main Bearing Upper Std. ★ | 2.25 | 1.15 |
| 5152979 | C/S Main Bearing Upper .010 | 2.25 | 1.15 |
| 5151980 | C/S Main Bearing Lower .010 | 2.25 | 1.15 |
| 5153582 | C/S Main Bearing Upper .020 | 2.25 | 1.15 |
| 5152583 | C/S Main Bearing Lower .020 | 2.25 | 1.15 |
| 5158674 | C/S Main Bearing Cap | 4.50 | 2.00 |
| 5158668 | C/S Main Bearing Cap Stud | 1.00 | .45 |
| 5150181 | Crankcase Front Cover Gasket | .25 | .11½ |
| 181397 | Crankshaft Damper Bolt 5159466 | .08 | .04 |
| 5158296 | Vibration Damper Hub Assly. | 10.00 | 3.50 |
| 5153622 | C/S Retainer Bolt | .40 | .18 |
| 5153615 | Flywheel Ring Gear 118 Teeth | 11.25 | 5.00 |
| 5158659 | Flywheel Hsg. Lge. Hole Cov. Gasket | .10 | .04½ |
| 5151538 | Conn. Rod Bearing Lower Std. | 2.25 | 1.15 |
| 5158694 | Conn. Rod Bolt | .40 | .18 |
| 5151550 | Conn. Rod Piston Pin Bushing | .65 | .55 |
| 5150106 | Conn. Rod Bearing Upper Std. ★ | 2.40 | 1.25 |
| 5151528 | Conn. Rod Bearing Lower Std. ★ | 2.25 | 1.15 |
| 5153075 | Conn. Rod Bearing Lower .010 | 2.25 | 1.15 |
| 5151318 | Conn. Rod Bearing Upper .020 | 2.42 | 1.25 |
| 5170206 | Cam & Bal. Shaft Gear LH (5152428) 2 Cylinder | 15.00 | 6.75 |
| 5151277 | Cam-Shaft Plug | .10 | .04½ |
| 5153951 | Cam-Bal Shaft End Bearing (5153922) | 6.00 | 2.70 |
| 5150917 | Cam & Bal. Shaft Thrust Washer | .50 | .25 |
| 5153914 | C/S Fr. Bal. Weight Key | .05 | .02½ |
| 5150084 | Fr. Bal. Weight Spring | .02 | .01 |
| 5150580 | Cam-Bal. Shaft Gear RH 41° | 20.00 | 9.00 |
| 5150516 | Crankshaft Gear RH Helix 41 Deg. | 15.00 | 6.75 |
| 5153270 | Cam-Bal Shaft Gear | 18.00 | 8.00 |
| 5153914 | Cam-Shaft Gear Key | .05 | .02½ |
| 5158568 | Cam-Bal Shaft Idler Gear | 20.00 | 9.00 |
| 5158274 | Cam-Bal Shaft Idler Gear Hub Assly. | 9.00 | 4.00 |
| 5158362 | Upper Push Rod Spring Seat | .05 | .02½ |
| 5150505 | Exh. Valve Rock Arm Assly. LH | 5.25 | 2.50 |
| 5158318 | Inj. Rocker Arm Bushing | .15 | .07 |
| 5159837 | Cam Follower Assly. | 3.00 | 1.50 |
| 5153737 | Exhaust Valve ★ | 1.75 | .90 |
| 5153297 | Exh. Valve Spring Seat | .25 | .12 |
| 5153299 | Exhaust Valve Spring | .35 | .16 |
| 5153210 | Exh. Valve Spring Cap | .15 | .07 |
| 5158290 | Exh. Valve Spring Lock | .05 | .02½ |
| **GROUP 2.000 FUEL SYSTEM** | | | |
| 5257231 | 80mm Injector & Case | 41.00 | 22.00 |
| 5256583 | Inj. Body Nut | 3.50 | 1.60 |
| 5256585 | Spill Deflector | 1.15 | .60 |
| 5256722 | Inj. Follower Guide | 2.30 | 1.10 |
| 5256888 | Inj. Filter Element | .20 | .09 |
| 5256415 | Inj. Filter Spring | .15 | .07 |
| 5256413 | Inj. Filter Cap | .55 | .27 |
| 5256186 | Injector Gaskets | .05 | .02 |
| 5257229 | Inj. Plunger & Bushing Assly. | 14.00 | 6.75 |
| 5257325 | Spray Tip & Valve Assly. ★ | 5.75 | 2.00 |
| | Consisting of: | | |
| | 1-5257323 Valve & Seat (Flat) 1.50 | | |
| | 1-5257318 Stop Check .40 | | |
| | 1-5257210 Valve Spring .50 | | |
| | 1-5257317 Spray Tip 7 Hole 2.50 | | |
| 5257317 | Injector Spray Tip 7 Hole | 3.50 | 1.50 |
| 5257323 | Inj. Valve (Flat) & Seat | 1.50 | .65 |
| 5257210 | Inj. Valve Spring | .50 | .22 |
| 5257318 | Inj. Stop Check | .40 | .18 |
| 5250249 | Injector Clamp | .75 | .35 |
| 5250031 | Fuel Trans. Pump | 27.00 | 13.50 |
| 5250193 | Tr. Pump to Blower Gasket | .05 | .02½ |
| 5250029 | Transfer Pump Dowel | .15 | .11 |
| 5250050 | Fuel Tran. Pump Doweled Pts. Assly. | 12.00 | 5.40 |
| 5250020 | Fuel Tran. Pump Rotor Vane | .55 | .25 |
| 1942005 | AC Fuel Filter Element T16 | 3.00 | 1.40 |
| 1935635 | Filter Element | 3.50 | 1.35 |
| 5156561 | Fuel Manifold Assly. Lower | 14.10 | 6.25 |
| 5151121 | Fuel Pipe Line | .50 | .25 |
| 5158905 | Mechanical Governor ★ | 98.00 | 41.00 |
| 5154402 | Governor Lever, Upper | 3.00 | 1.35 |
| 5158992 | Gov. Weight Housing Assly. | 56.00 | 25.00 |
| 5159890 | Gov. Wgt. Hse. Cover Gasket | .05 | .02½ |
| 5151604 | Low-Speed Governor Spring ★ | .25 | .12 |
| 5151249 | Gov. Spring Shim (078") | .05 | .02½ |
| 5150260 | Lever Rack Control Assly. | 1.90 | .85 |
| 5153618 | Inj. Control Screw | .05 | .05 C |
| 5159004 | Gov. Control Shaft-Steel 3/8" Round x 13/16"—5167287 | 1.67 | .30 |
| **GROUP 3.000 AIR INTAKE SYSTEM** | | | |
| 5157393 | Blower Assly. (Left) ★ | 236.50 | 125.00 |
| 5157396 | Blower Assly. (Right) ★ | 236.50 | 125.00 |
| 5150237 | Blower Gasket | .55 | .25 |
| 903265 | Front Blower Rotor Bearing | 2.36 | 1.25 |
| 5153372 | Blower Rotor Gear Shim .002 | .05 | .02 |
| 5154401 | Blower Fuel Pump Disc | .40 | .18 |
| 5154400 | Bl. Rotor Gear Ret. Washer | .25 | .12 |
| 5158478 | Blower Drive Gear | 7.00 | 3.25 |
| 5150279 | Blower Hub | 9.00 | 4.00 |
| **GROUP 4.000 ENGINE LUBRICATING SYSTEM** | | | |
| 5166520 | Oil Pump Assly. | 49.00 | 24.50 |
| 5163080 | Oil Pump Shim .005 | .05 | .02½ |
| 5153200 | Oil Pump Dowel | .17 | .08 |
| 5153324 | Oil Pump Body | 17.00 | 7.75 |
| 5153147 | Oil Pump Body Bushing | .20 | .09 |
| 5153257 | Oil Pump Spacer | 2.13 | .95 |
| 5153300 | O.P. Drive Shaft | 2.50 | 1.00 |
| 5153260 | Oil Pump Drive Gear | 5.00 | 2.25 |
| 5153617 | Oil Pump Driven Gear | 7.50 | 3.40 |
| 5153765 | Oil Pump Relief Valve Spring | .25 | .12 |
| 5152613 | Oil Pump Plugs | .20 | .09 |
| 5156653 | Oil Pump Idler Gear | 7.50 | 3.50 |
| 5156528 | Oil Pump Drive Driven Gear | 7.50 | 3.50 |
| 5153313 | O.P. Inlet Pipe Gasket | .05 | .02½ |
| 5570681 | Senior Military Oil Filter Assly. | 25.00 | 8.50 |
| 5150160 | Oil Filter Body (064443) | 3.50 | 1.50 |
| 1503518 | Secondary Oil Filter Spring | .28 | .12 |
| 8502957 | Oil Cooler Element 12 Stack | 45.50 | 20.00 |
| 5150155 | Oil Cooler Hsg. Inner Gasket | .15 | .07 |
| 5150154 | Oil Cooler Adaptor-to-Block Gasket | .05 | .02½ |
| 5158868 | Oil Pan Drain Plug | .20 | .09 |
| 5166723 | Engine Breather Tube Assly. | 2.42 | 1.00 C |
| 140573 | #8 Closed Clips ⅛" Dia. x ¼" Bolt Hole | .03 | .03 |
| 5163909 | Engine Oil Breather Separator Housing (for 5163908 Assly.) | 20.00 | 7.00 |
| **GROUP 5.000 ENGINE COOLING** | | | |
| 5159059 | Fresh Water Pump | 21.50 | 10.00 |
| 5150193 | Fr. Water Pump Gasket | .05 | .02½ |
| 5151412 | Water Pump Impeller w/Seal ★ | 5.00 | 2.25 |
| 5973356 | Fr. Water Pump Seal Spring Guide | .06 | .03 |
| 5150191 | Fresh Water Pump Outlet Packing | .10 | .04½ |
| 5156502 | Water By Pass Tube Assly. (same as 3229517) | 9.64 | 3.75 |
| 5157704 | Thermostat Assly. ★ | 1.75 | .80 |
| 5157775 | Thermostat Seal ★ | .03 | .01½ |
| 5167062 | Radiator Core Assly. 3 Cyl. | 112.00 | 50.00 |
| 5167063 | Radiator Core Assly. 4 & 6 Cyl. | 132.00 | 60.00 |
| 5158079 | Fan Drive Gear & Bal. Wgt. (Used on Twins) | 20.00 | 10.00 |
| 5158060 | Fan Drive Idler Gear Shaft | 5.00 | 2.25 |
| 903295 | Fan Shaft Inner Bearing | 2.38 | 1.25 |
| 5156926 | Heat Exchanger Priming Cap | 2.48 | .75 |
| 5158614 | Raw Water Pump 5192044 ★ | 138.50 | 62.50 |
| 5192043 | Raw Water Pump Housing Front | 23.10 | 6.25 |
| 5161017 | Raw Water Pump Rear Housing | 28.50 | 8.50 |
| 5161018 | Raw Water Pump Hsg. Spacer | .80 | .35 |
| 5161025 | Raw Water Pump Shaft | 10.97 | 5.00 |
| 5161023 | Raw Water Pump Impeller-Neoprene | 10.00 | 6.00 |
| 5161021 | Raw Water Pump Drive Gear | 6.81 | 3.25 |
| 5161022 | Raw Water Pump Driven Gear | 6.23 | 2.75 |
| 5160156 | Raw Water Pump Inlet Elbow 1 ⅝"ID 2"OD Bronze | 4.00 | 2.00 |
| **GROUP 6.000 ENGINE EXHAUST** | | | |
| MUW-1 | Maxim Exhaust Silencer No. 5 2½" Heresite Finish 14"x8" Cylinder 22" Overall Complete with Flanges—Government Cost 100.00 | 165.00 | 50.00 |
| 5157888 | Exhaust Manifold (Not water cooled) | 71.50 | 28.50 |
| 5150196 | Exh. Manifold Inter. Gasket | .15 | .07 |
| **GROUP 7.000 ELECTRICAL INSTRUMENTS** | | | |
| 1108732 | DR Starter 12 V. ★ | 150.00 | 25.00 |
| 1838340 | DR Generator Brush | .75 | .25 |
| 828448 | Delco Remy Starter Brush | .20 | .09 |
| 179927 | Starter Motor Assly. Bolt (181396) | .06 | .02½ |
| 1118078 | Solenoid Switch Assly. 12 volt | 10.50 | 4.75 |
| 1904984 | Starting Motor Brush | .40 | .15 |
| 8859151 | Ammeter 100-50-0-50-100 2½" Flange Face Stewart-Warner | 4.00 | 1.25 |
| 0-200 lbs. | Water Temp. Gauge Adapter | .65 | .10 |
| 1511085 | Oil Pressure Gauge 2½" Dia. Stewart-Warner | — | 1.10 |
| 1536005 | AC Water Temperature Gauge w/50" Capillary Tube 100-220 | 13.03 | 5.50 |
| 1536021 | AC Tachometer Flex. Dr. Shaft Assly. 10 feet | 15.00 | 6.00 |
| 5150039 | AC Tachometer Flex. Dr. Shaft Assly. 16 ft. | 12.00 | 5.00 |
| 5150020 | Flywheel Hsg. Lge. Hole Cover Gskt. | .10 | .04½ |
| 5153585A | Air Heater Gasket | .10 | .05 |
| 5158594 | Air Heater Body & Cover Assly. Includes: Insulator Nozzle Filter, Electrode Misc. Parts | 14.50 | 7.25 |
| 32-212 | Air Heater Ins. Gasket | .05 | .02½ |
| 1118118 | Water Temperature Gauge w/15 ft. Capillary Tube Stewart-Warner | 10.00 | 5.00 |
| 5151922 | Shut-off Alarm Solenoid Switch | 12.00 | 5.50 |
| 5152909 | DR Generator 12 V. | 36.00 | 20.00 |
| | Heater Pump (Dole) ★ | 10.50 | 3.00 |
| | Heater Pump Plunger | 0.93 | 1.25 |
| **GROUP 8.000 POWER TAKE OFF** | | | |
| 179927 | Clutch Bearing Housing Bolt (181396) | .06 | .02½ |
| 5157536 | Clutch Release Bearing Seal | 1.00 | .45 |
| 119512 | Lubrication Fitting ¼" Str. | .05 | 2.50 C |
| **GRAY MARINE PARTS** | | | |
| A5215A | Twin Disc Countershaft (5190742) | 45.00 | 22.50 |
| A-3321A | Twin Disc Reverse Pinion (5164472) | 20.00 | 10.00 |
| A3321 | Twin Disc Reverse Pinion (5190737) | 20.00 | 10.00 |
| 5164469 | Marine Transmission Idler Gear | 50.00 | 12.50 |
| 5151544 | Vibration Damper Cone | 2.50 | 1.25 |
| 1904984 | Delco Remy Starter Brush | .40 | .15 |
| 1118078 | Solenoid Switch Assly. (12 volt) | 10.50 | 4.75 |
| D546-132 | Generator Drive Pulley | 4.50 | 2.75 |
| 853694 | Lube Oil Filter Assly. ★ | 42.00 | 16.50 |
| 853768 | Lub. Oil Filter Element (Fram C102D) | 2.00 | 1.00 |
| D28-JWM-16 | Fuel Oil Filter Assly. (Primary) ★ | 42.00 | 16.50 |
| 853695 | Fuel Filter Assly. T1 (Secondary) ★ | 12.50 | 6.25 |
| T2 | AC Secondary Fuel Oil Filter Assly. (Similar to 5561218 w/Disc Stack Element) | 15.00 | 9.00 |
| 1505634 | Secondary AC Fuel Filter Element & Gasket Set Consists of: 1—853558 Gasket 1—853572 Gasket | 3.25 | 1.30 |
| 5152992 | Oil Pump Drive Chain | 5.25 | 2.50 |
| 5156826 | Oil Pressure Regulator Body | 3.00 | 1.50 |
| D46-234 | Lubricating Oil Pump Screen Assly. | 6.65 | 2.75 |
| D6-380 | Oil Cooler Element 12 Stack | 52.50 | 20.00 |
| D6-836C | Sea Water Pump | 138.50 | 62.50 |
| D6-836C | Sea Water Pump | 95.00 | 47.50 |
| D6-437 | Sea Water Pump Gear Plate | .70 | .30 |
| D6-443 | Sea Water Pump Shaft Nut | .15 | .07 |
| D6-550 | Sea Water Pump Impeller (Neoprene) ★ | 10.00 | 6.00 |
| D6-451 | Sea Water Pump Drive Gear 1 7/16" | 6.81 | 3.25 |
| D6-452 | Sea Water Pump Driven Gear 1" | 5.40 | 2.75 |
| D6-456 | Sea Water Pump Dowel Pin | .10 | .04 |
| D6-531 | Sea Water Pump Shaft | 10.97 | 5.00 |
| D6-535 | Sea Water Pump Gear Housing | 25.00 | 8.50 |
| D6-554 | Sea Water Pump Inlet Elbow 1⅝" ID 2" OD Bronze | 4.00 | 2.00 |
| D6-737 | Sea Water Pump Pkg. Gland | .60 | .25 |
| D6-740 | Sea Water Pump Adaptor | 18.75 | 6.25 |
| X140725 | Sea Water Pump Bolt Adpt.-Housing | .05 | .02 |
| X100147 | Sea Water Pump Bolt 7/16-14-1¼ | .04 | .02 |
| X106341 | Sea Water Pump ⅝-13-1 ½ | .05 | .02 |
| X5006 | Sea Water Pump Grease Cup Size 0 | 1.00 | .45 |
| X5014 | Sea Water Pump Bearing | 2.60 | 1.25 |
| 1511401 | Sea Water Temp. Gauge | 22.00 | 8.50 |
| D6-470 | Water Outlet Manifold | 27.00 | 12.00 |
| 860889 | AC Tachometer Adaptor Swivel 1x1 | 5.25 | 2.50 |
| E 193 | Crankshaft Oil Seal ★ | 1.55 | .40 |

**All prices f.o.b. Brooklyn . . . . write or wire . . . .**

*Benjamin's for Motors*

**2090 MILL AVENUE BROOKLYN, NEW YORK**

### New Vernier Caliper

GEORGE Scherr Company announces the manufacture in Switzerland, under its trade name, of a Rustless Chrome Vernier Caliper which enables the mechanic and toolmaker to measure from 0-6" in 1/1000" and 1/64" for outside, inside and depth dimensions. The blade and jaws of the tool are hardened throughout. It is well known that the blade of an ordinary Vernier Caliper soon develops wear and is very easily damaged. In the Scherr Vernier Caliper this disadvantage has been overcome by making the slide of rustless chrome and of such a degree of hardness in comparison with the bar, that the wear between the two members is virtually negligible making for extremely long life. Complete information on the Rustless Chrome Vernier Caliper may be obtained from the George Scherr Company, 200 Lafayette St., New York 12, New York.

Scherr vernier caliper

## Kilroy Is Here

J. H. ADLER, inventor of Kilroy, seen with his new portable service station. Capable of servicing mechanized units operating on heavy construction jobs, Kilroy, named after that ubiquitous "GI," weighs 18,000 lbs. which includes 3½ tons of fuel and lubricant. An air compressor supplies the power to operate all pumps. The new unit is now in production by Jax Inc. of Pittsburg.

## National Instrument Conference

MORE than 65 per cent of the exhibit space for the Third National Instrument Conference and Exhibit, to be held September 13 to 17 at Convention Hall, Philadelphia, has already been allocated, it was announced recently by the Allocation Committee of the Instrument Society of America. The demand for exhibit space was said to be the heaviest and earliest which has been experienced.

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